United States Patent [19]

Barriquand et al.

[11] **Patent Number: 4,716,659**

[45] **Date of Patent: Jan. 5, 1988**

[54] **METHOD AND INSTALLATION FOR REMOVING WATER FROM, DRYING AND/OR CONDITIONING FIBROUS, POROUS OR FILAMENT MATERIALS**

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[73] Assignee: **Barriquand,** Roanne, France

[21] Appl. No.: **848,142**

[22] Filed: **Apr. 4, 1986**

[30] **Foreign Application Priority Data**

Apr. 5, 1985 [FR] France 85 05266

[51] **Int. Cl.**[4] **F26B 3/06**

[52] **U.S. Cl.** **34/15;** 34/92; 34/104

[58] **Field of Search** ..... 34/15, 92, 104, 105; 68/5 L, 7, 20

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Primary Examiner—Albert J. Makay
Assistant Examiner—David W. Westphal
Attorney, Agent, or Firm—Oblon, Fisher, Spivak, McClelland, & Maier

[57] **ABSTRACT**

A method and installation for removing water from, drying and/or conditioning fibrous, porous or filament materials. A stream of gaseous fluid is caused to flow through an enclosure, by means of a plurality of flow means, so that it passes through the materials to be treated under reduced pressure and/or with over pressure, from the inside towards the outside of the materials, or vice versa, and a stream of water vapor is caused to pass through said materials so as to accelerate the removal of water at the beginning of drying and/or to rapidly raise the temperature of the treated materials and/or to spray said materials, if desired, during drying.

22 Claims, 26 Drawing Figures

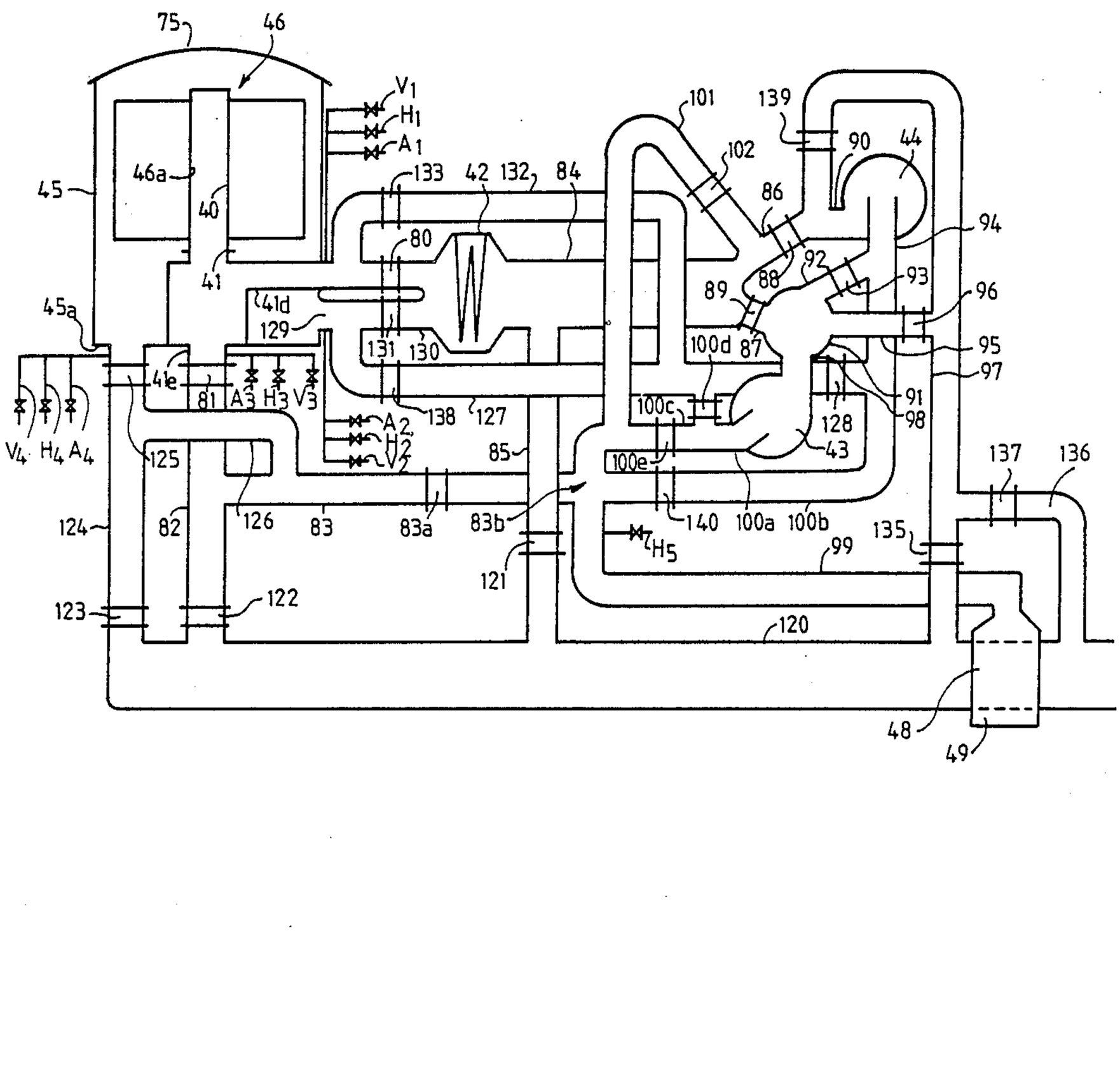

FIG. 1

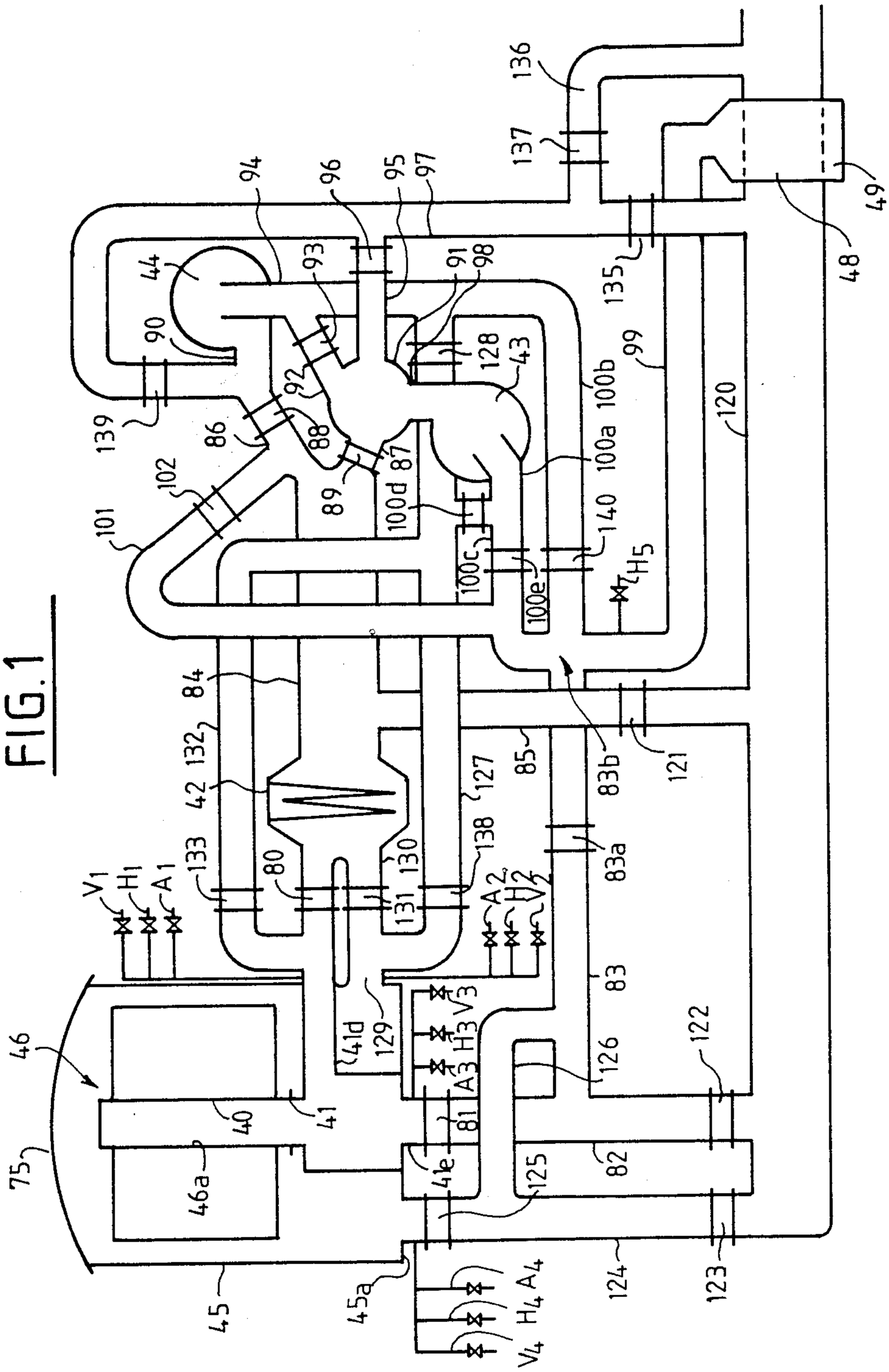
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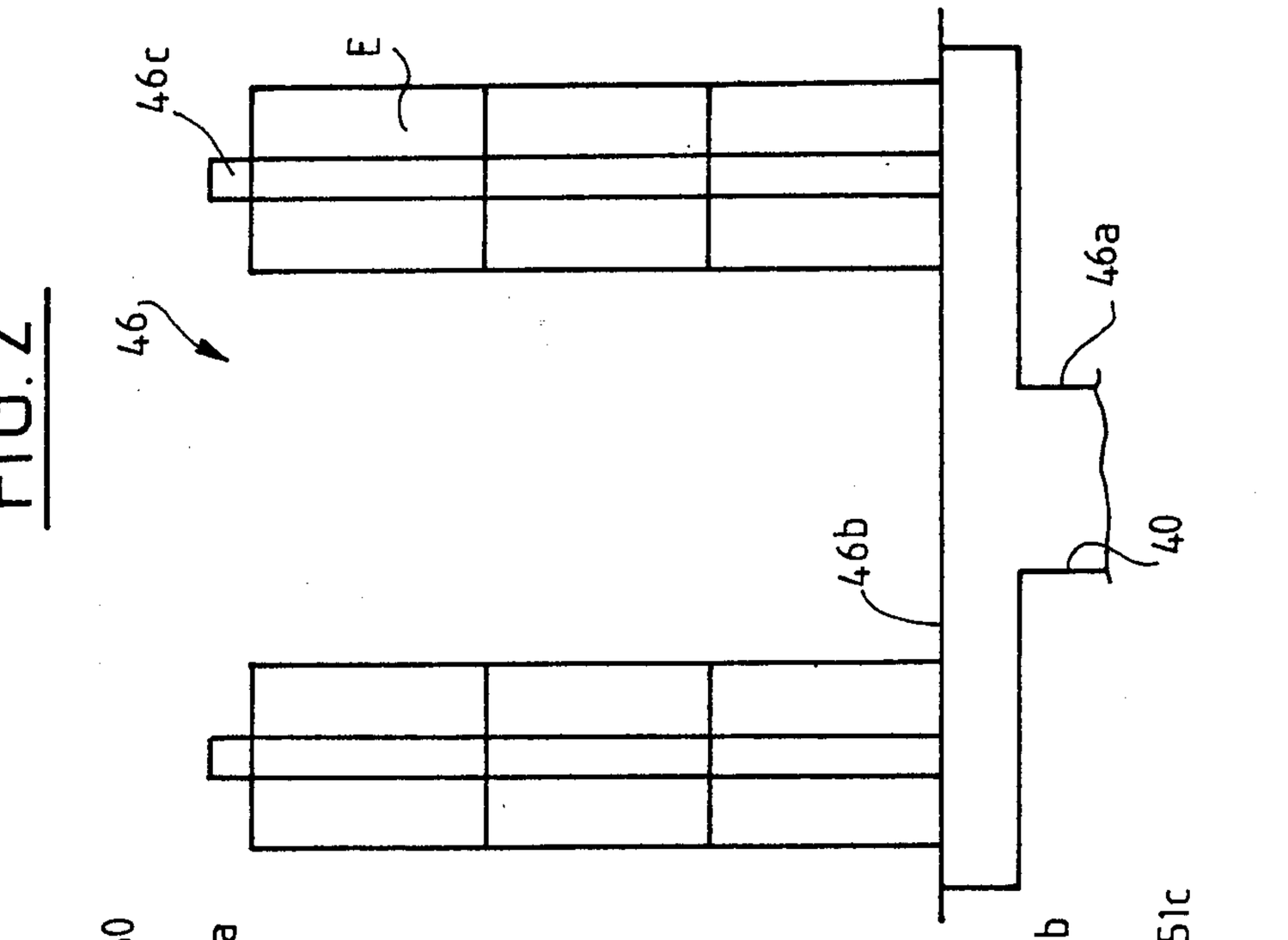
FIG. 2



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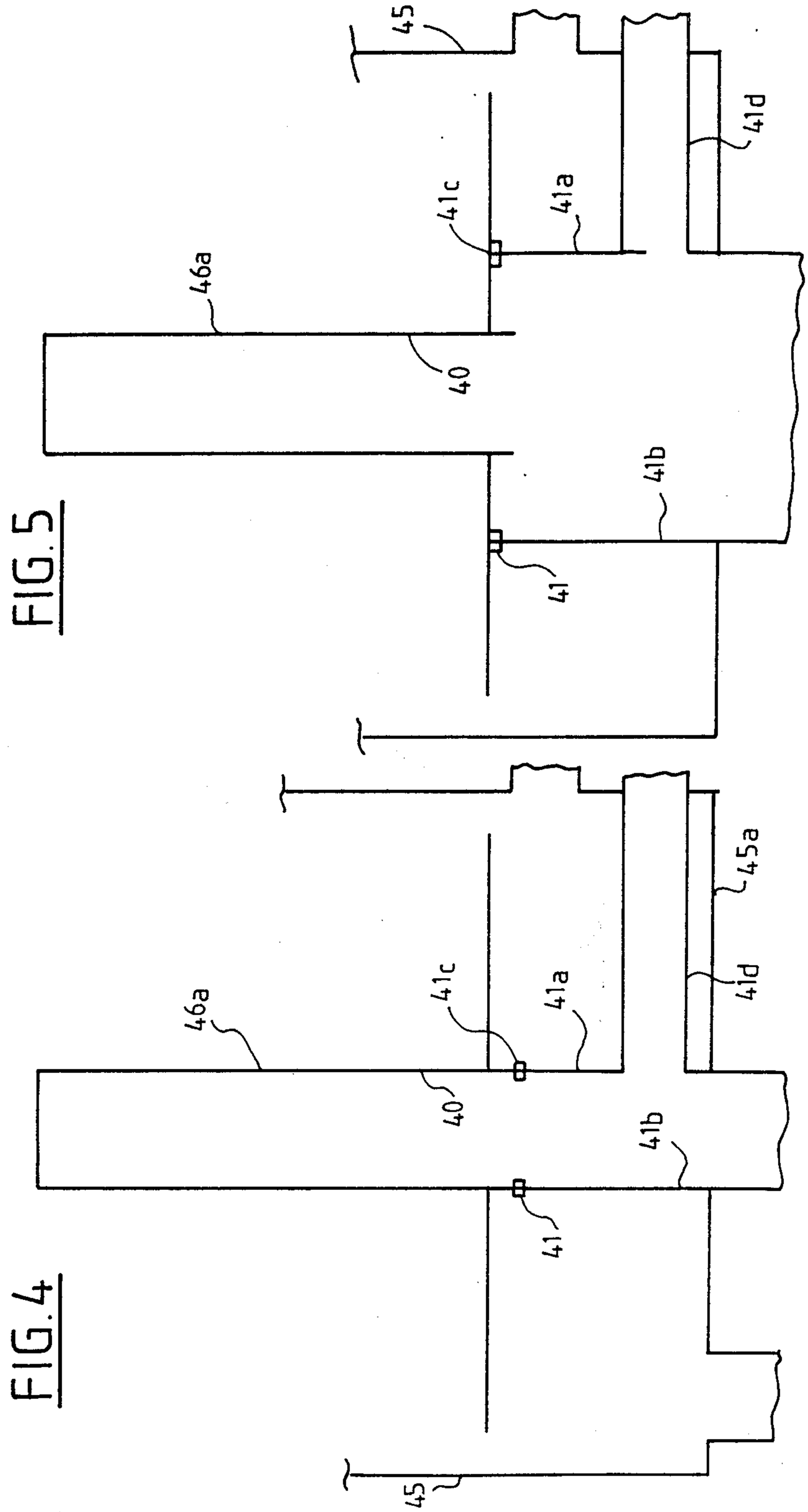

FIG. 5

FIG. 4

FIG. 6

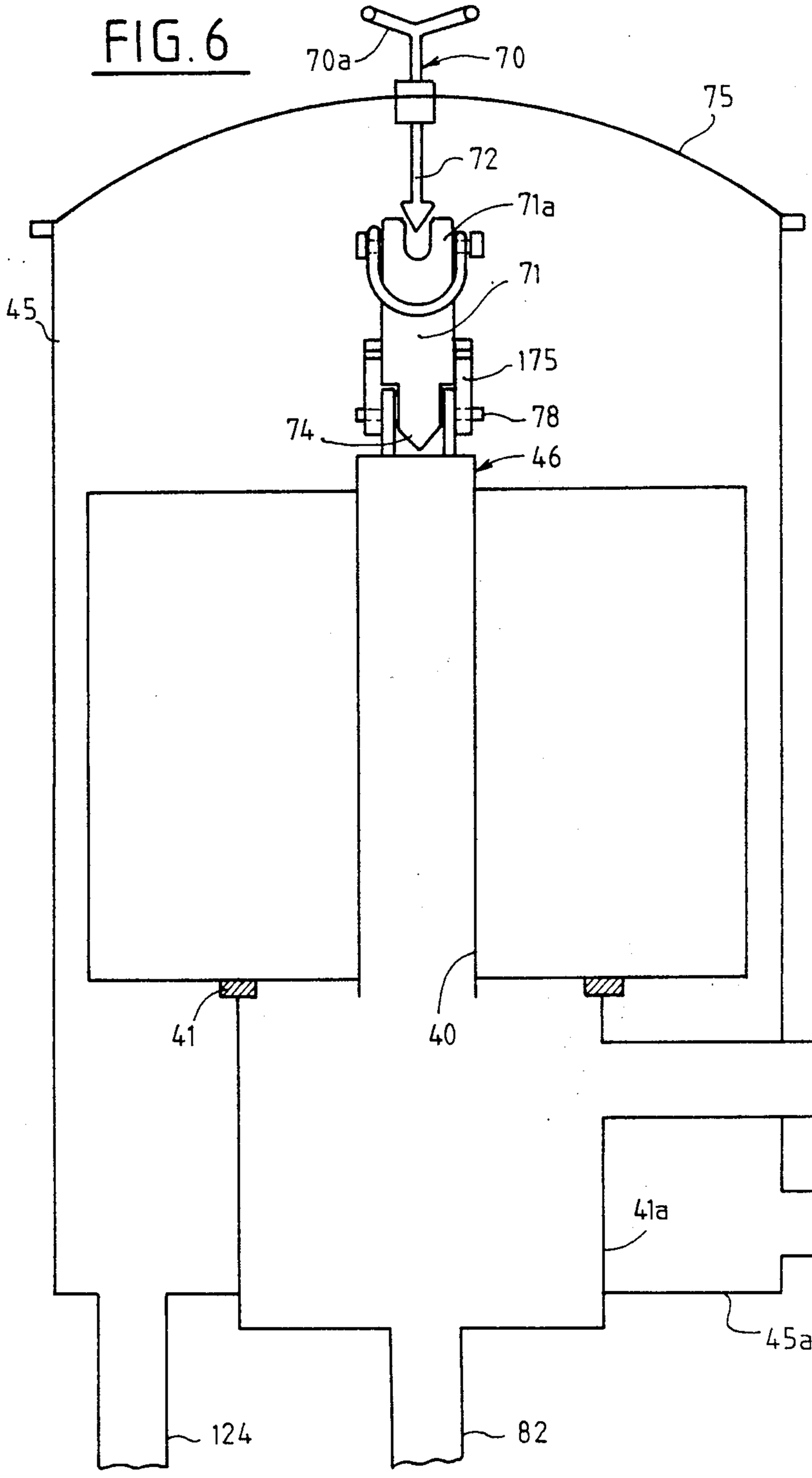
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FIG. 6a

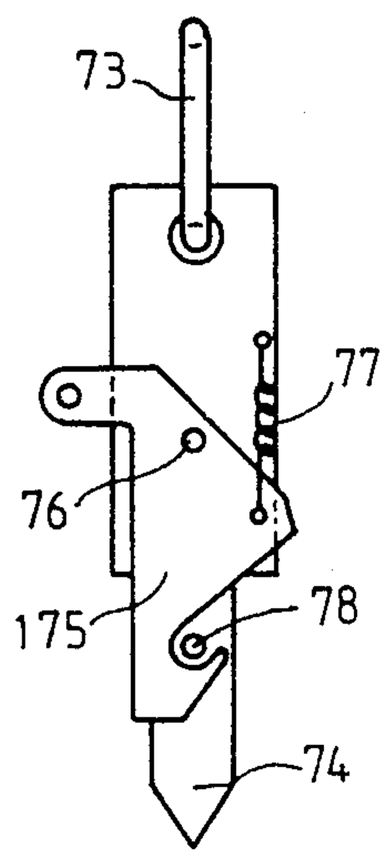
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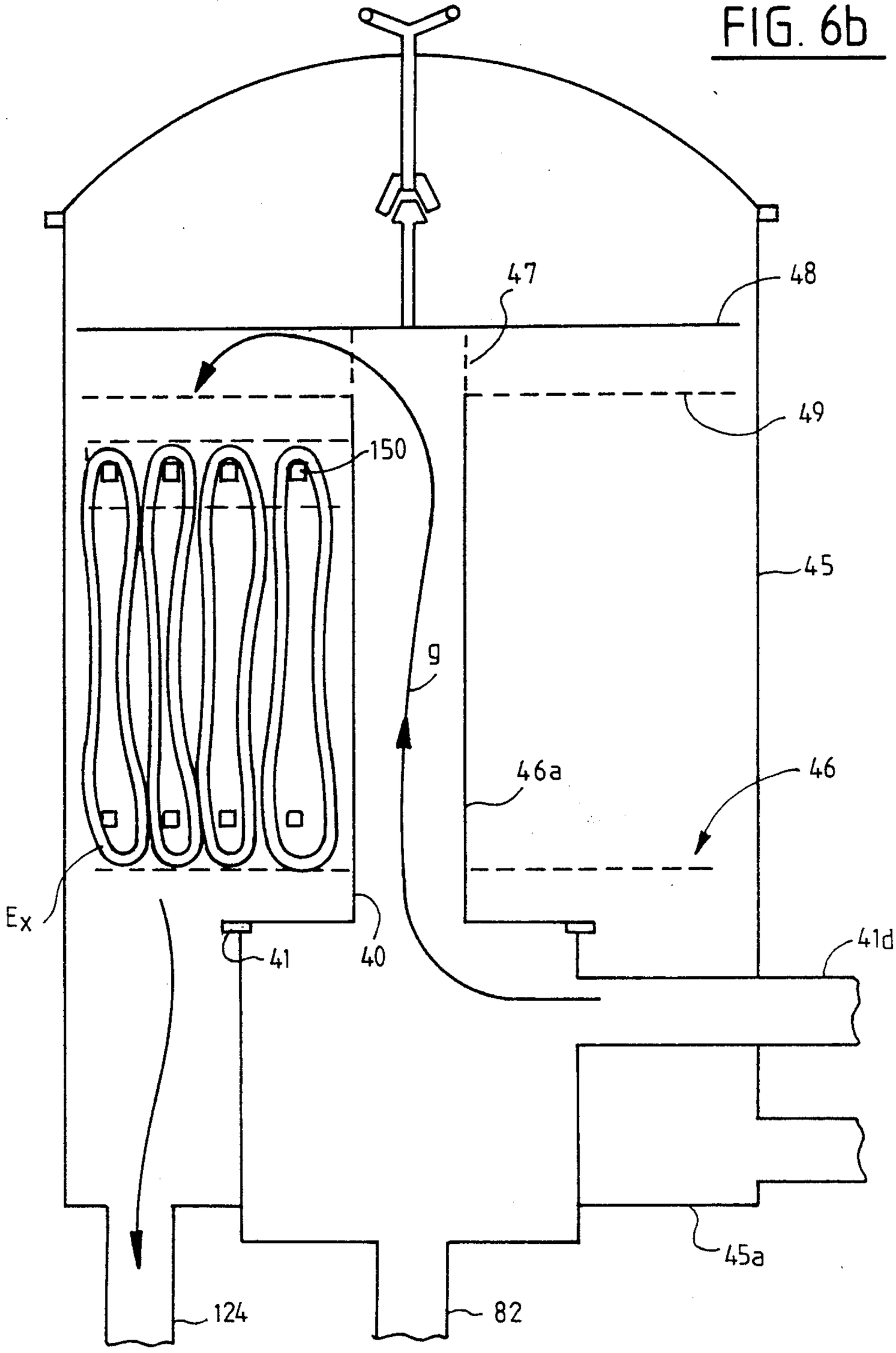
FIG. 6b



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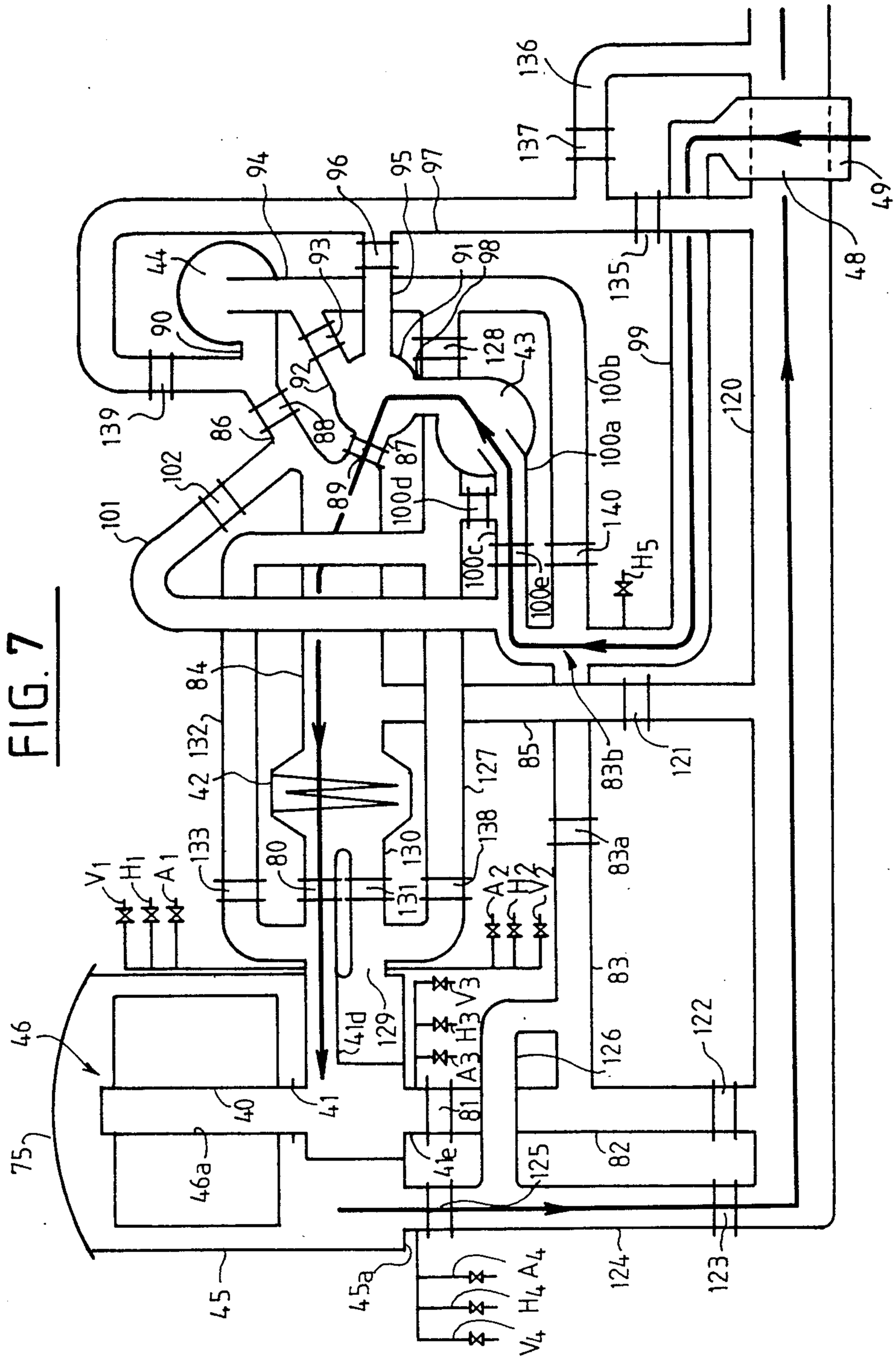
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FIG. 8

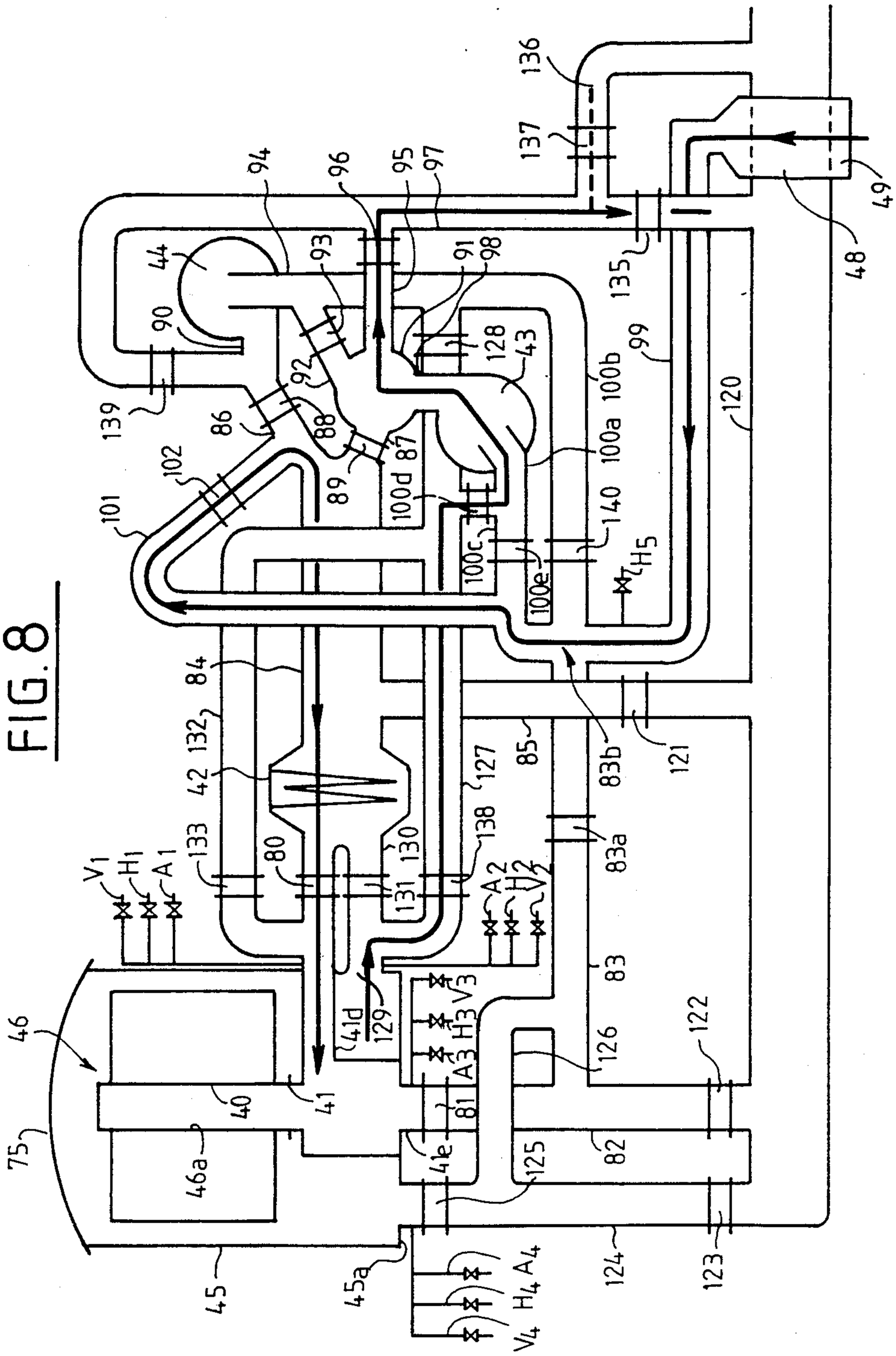
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FIG. 9

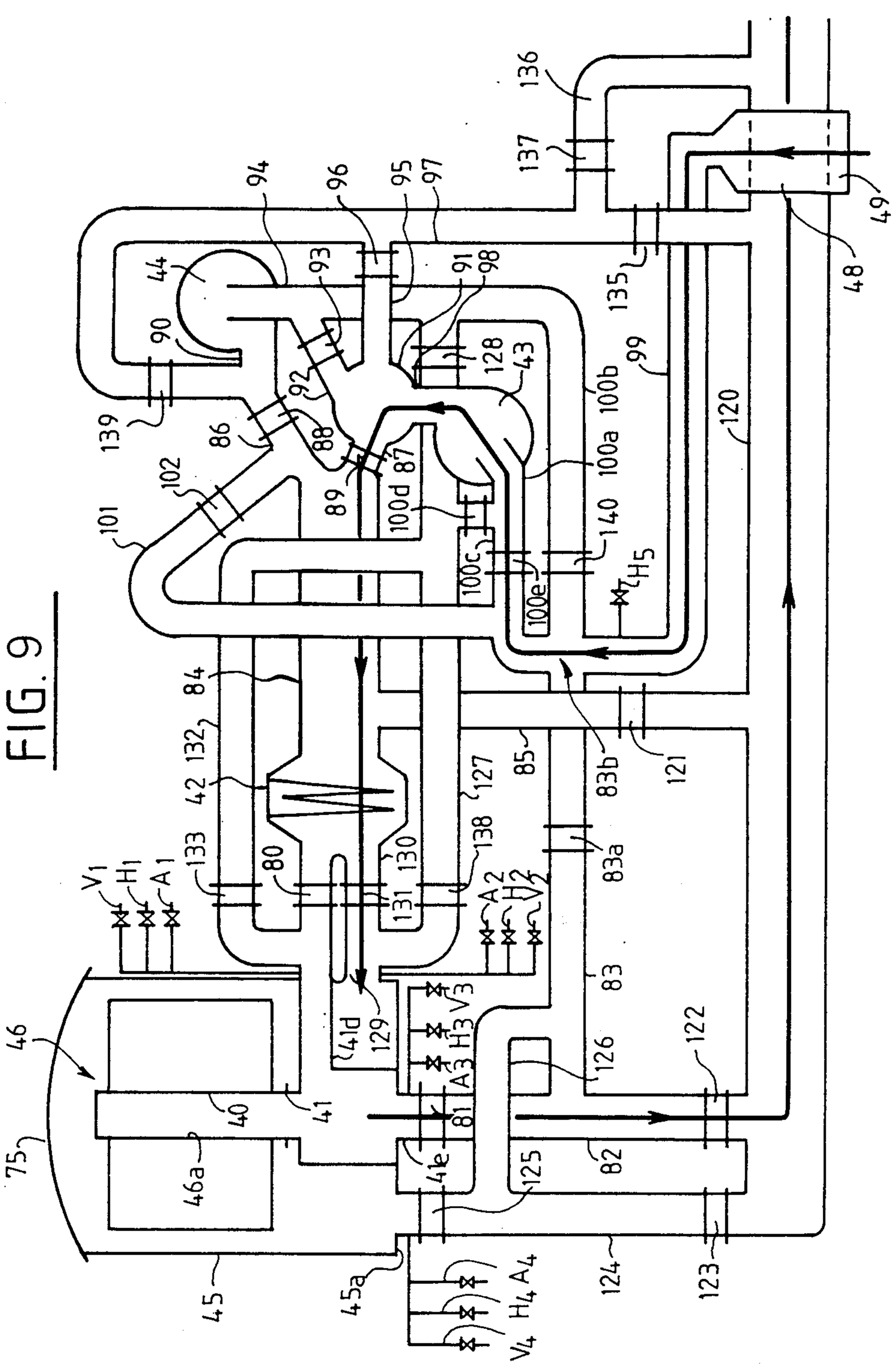
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FIG. 10

FIG. 11

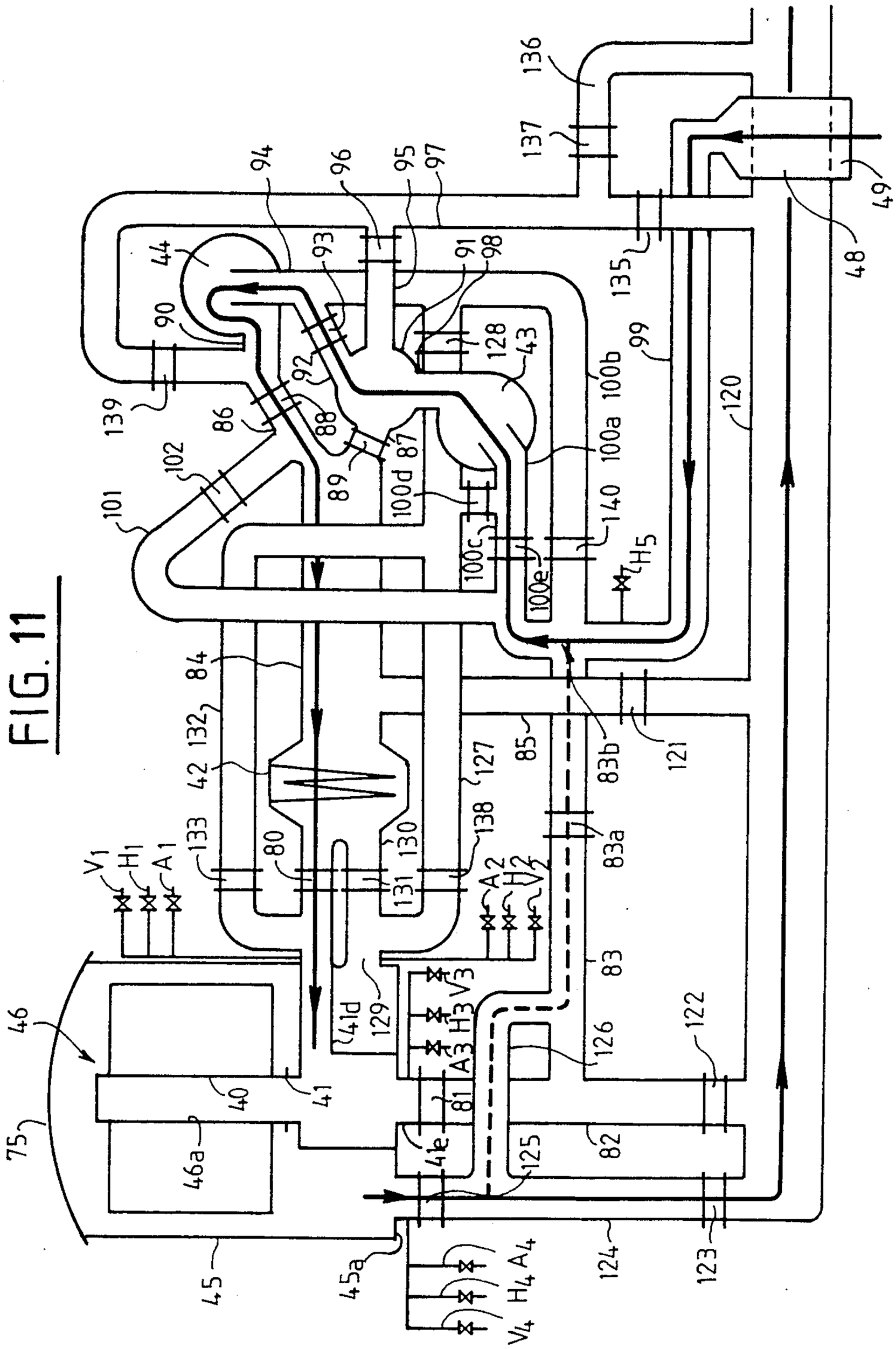
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FIG. 12

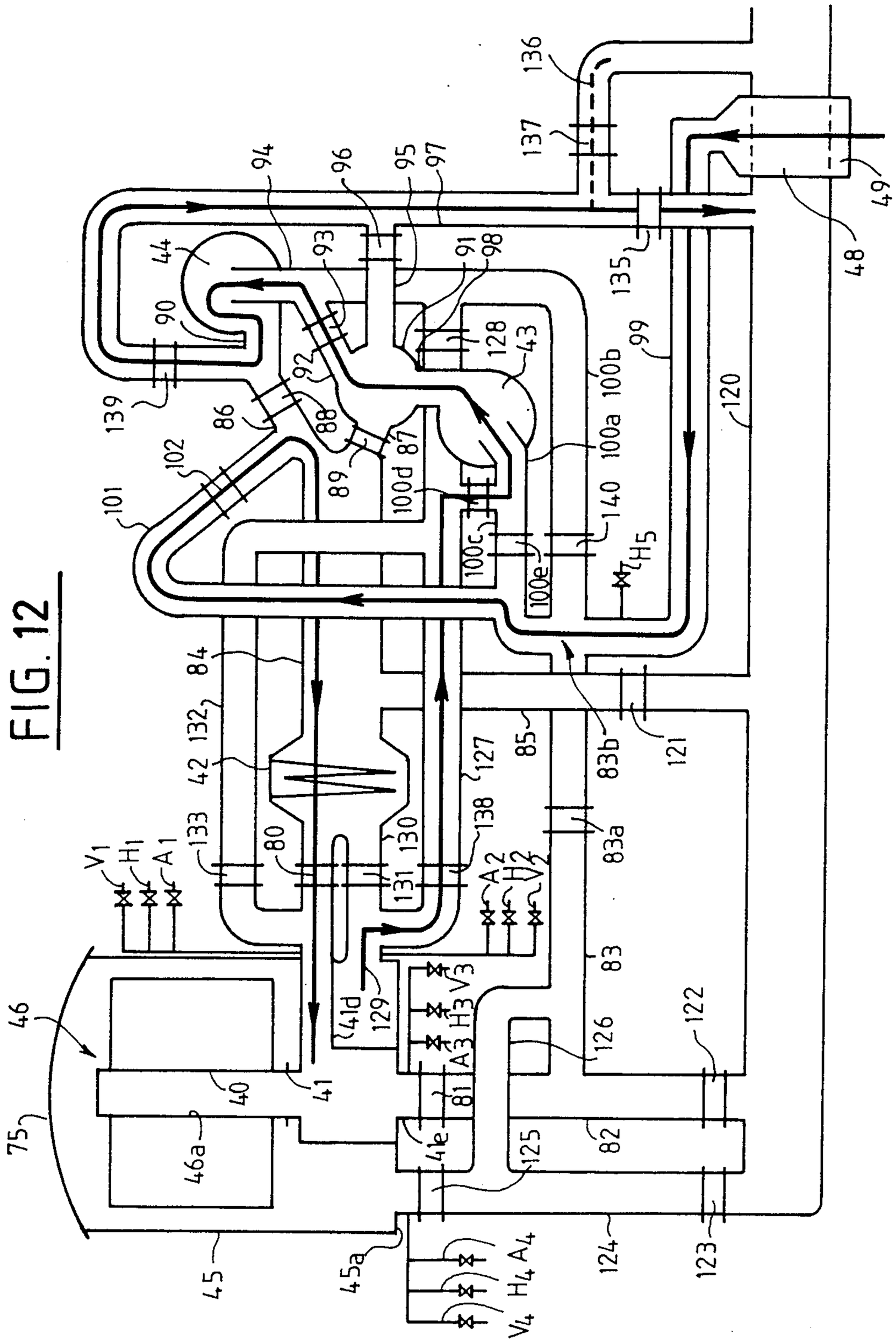
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FIG. 13

FIG. 14

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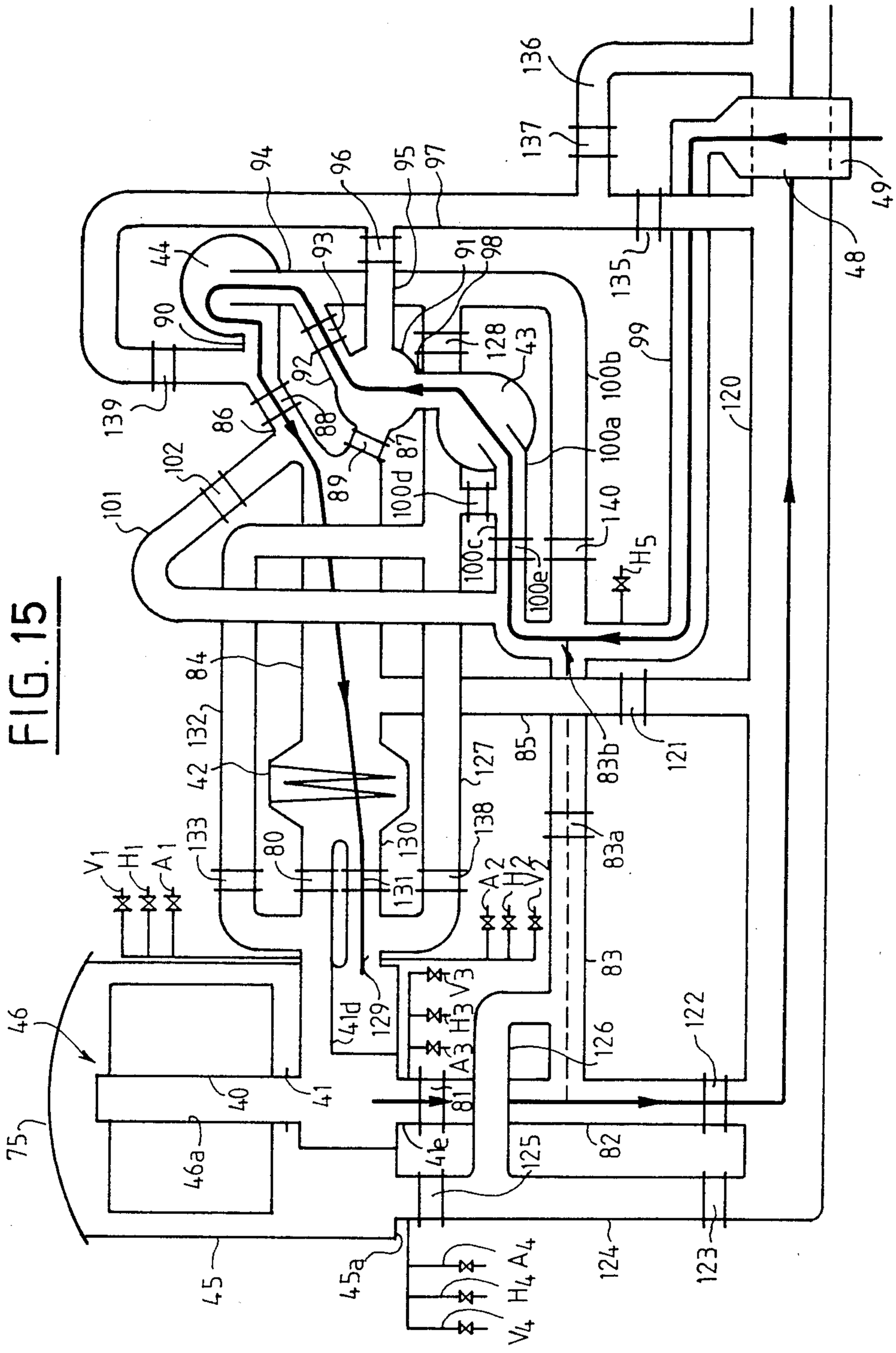
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FIG. 16

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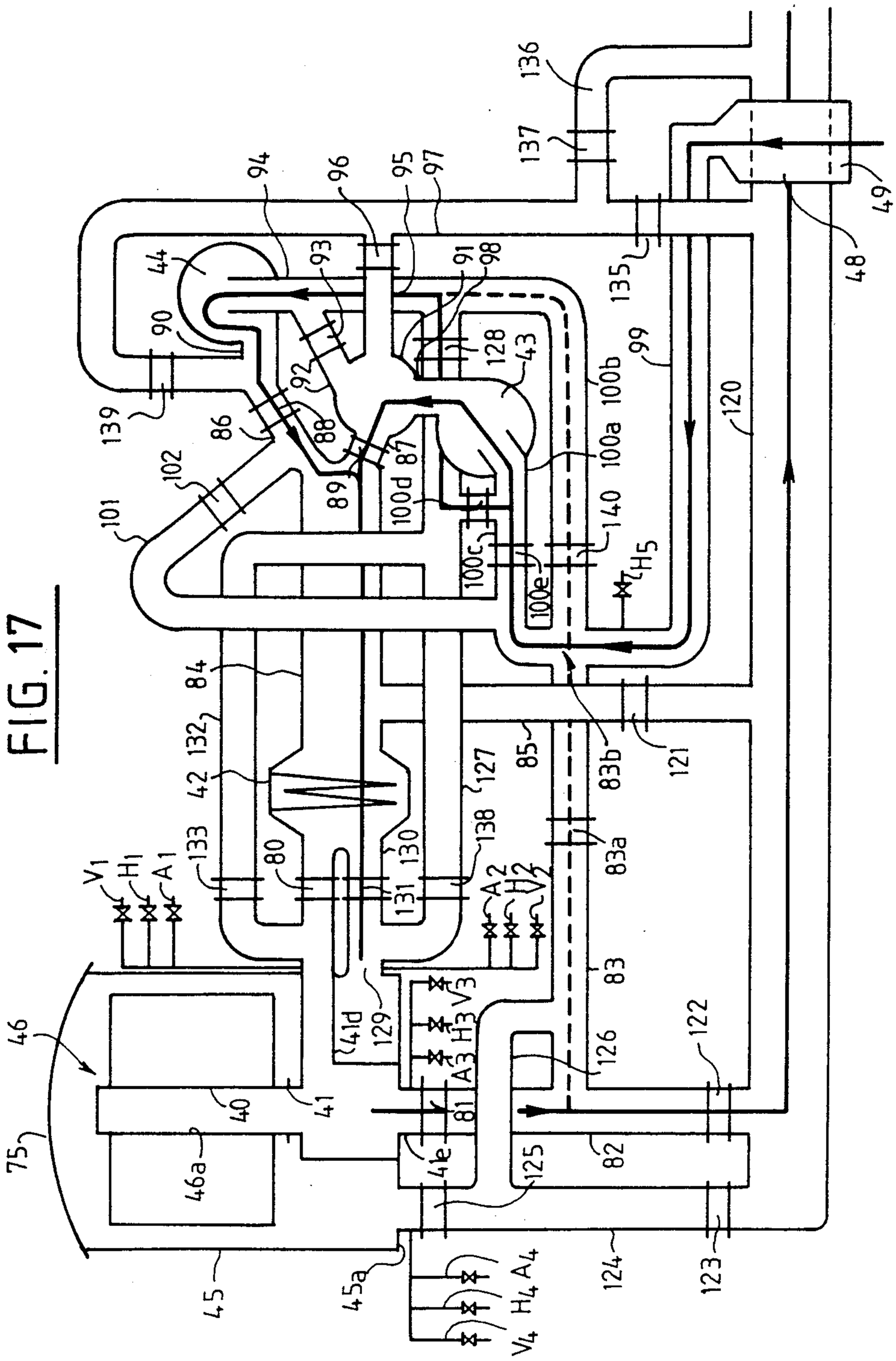
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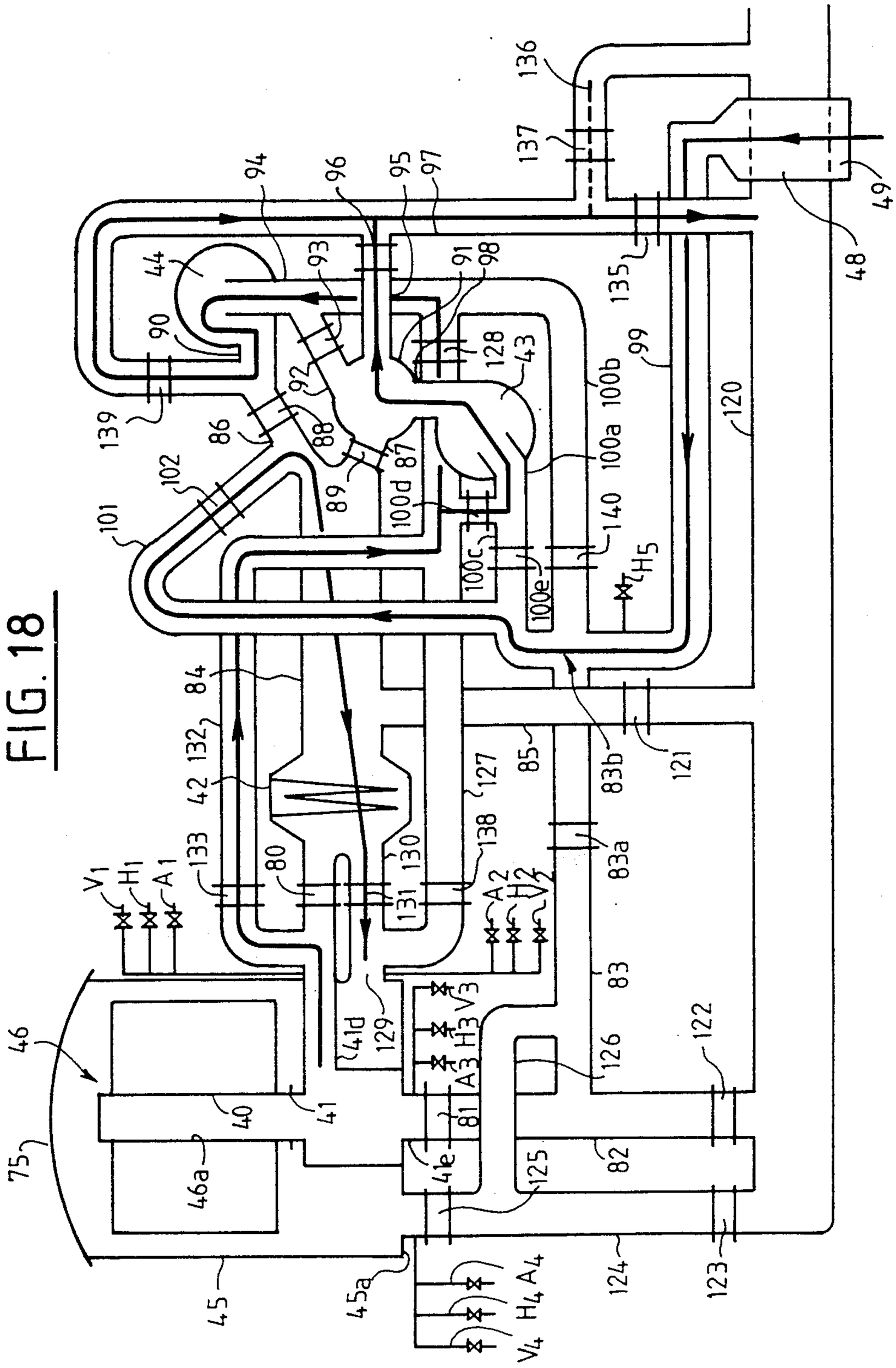
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FIG. 19

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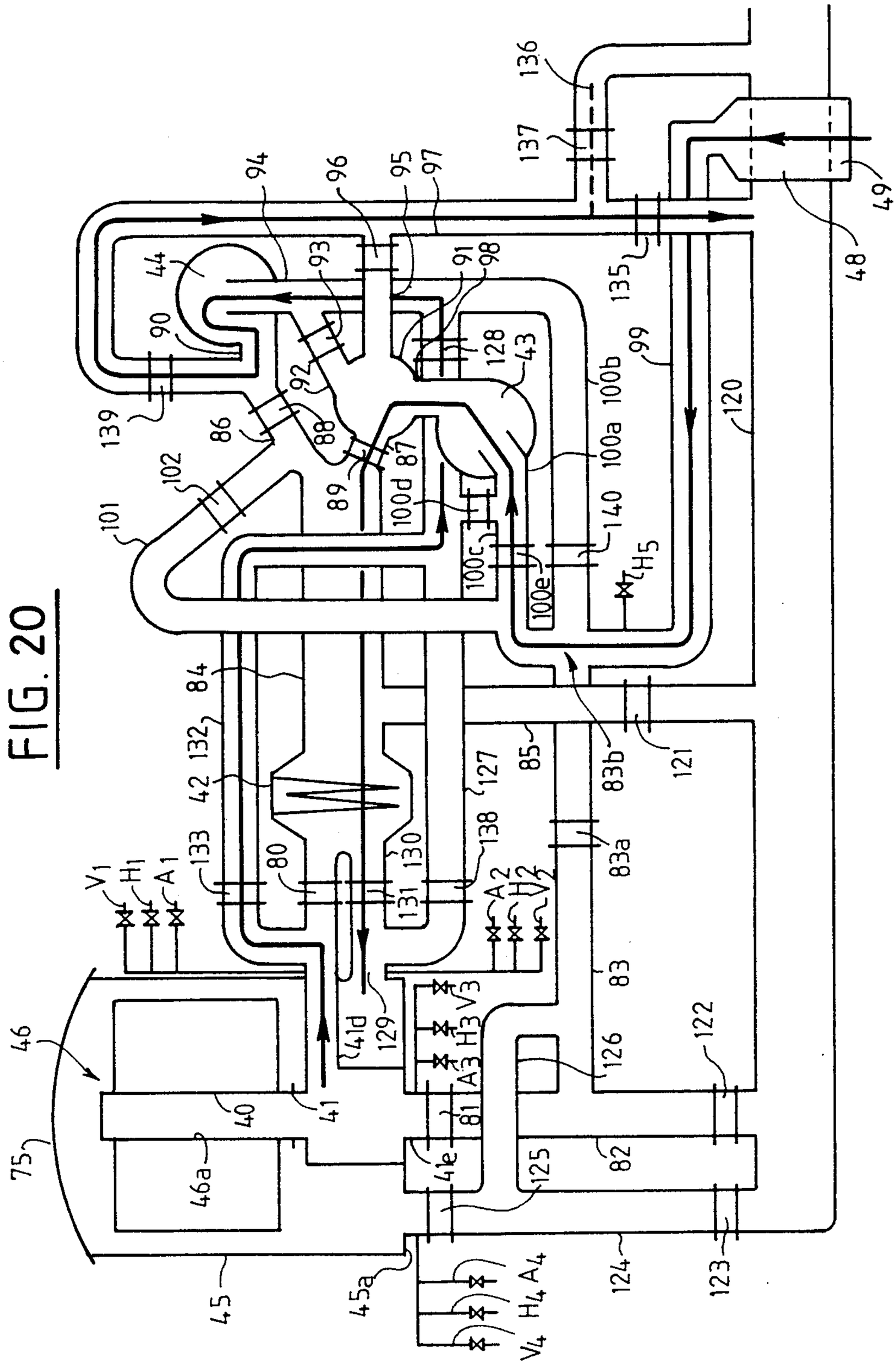
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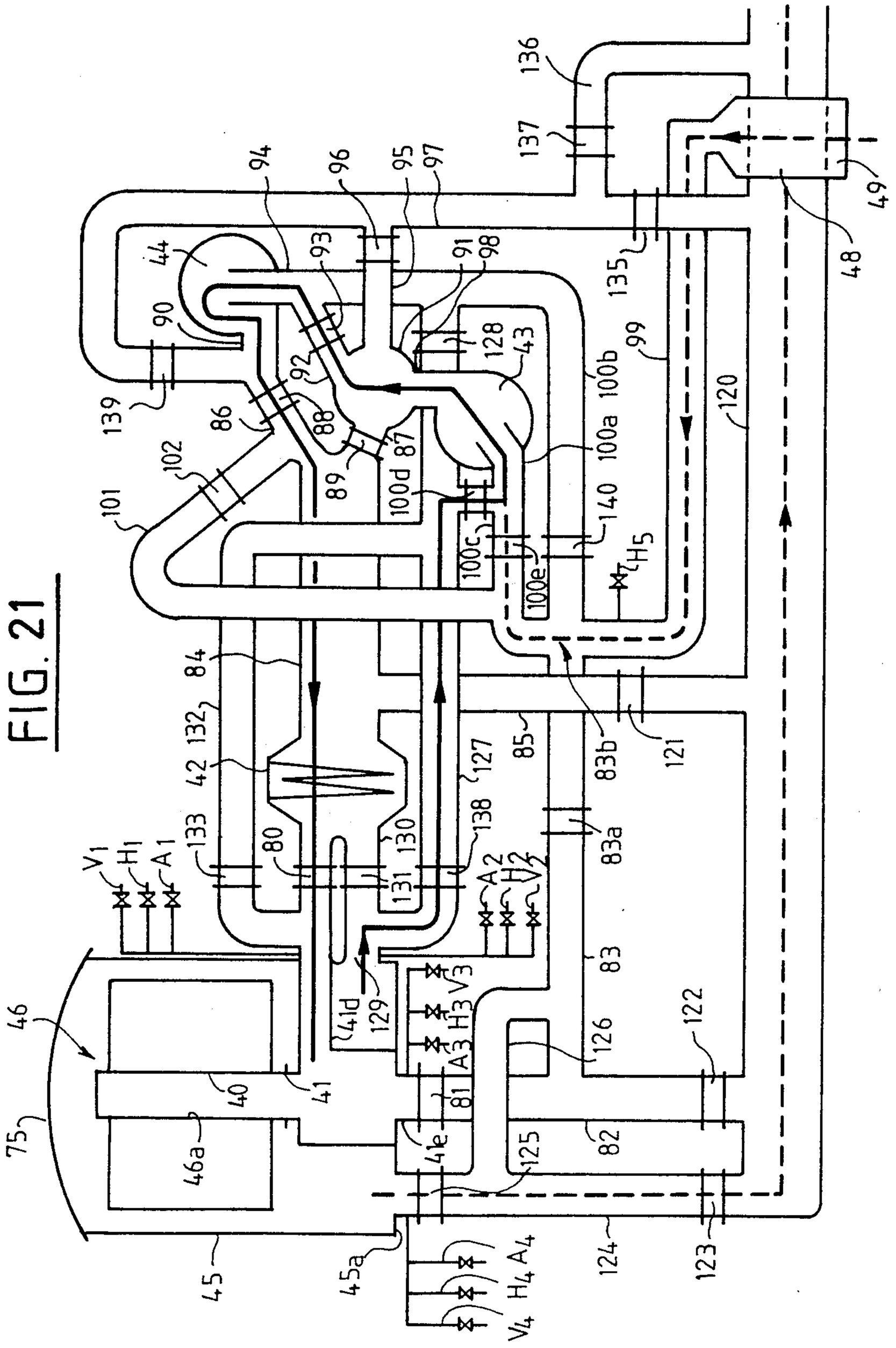
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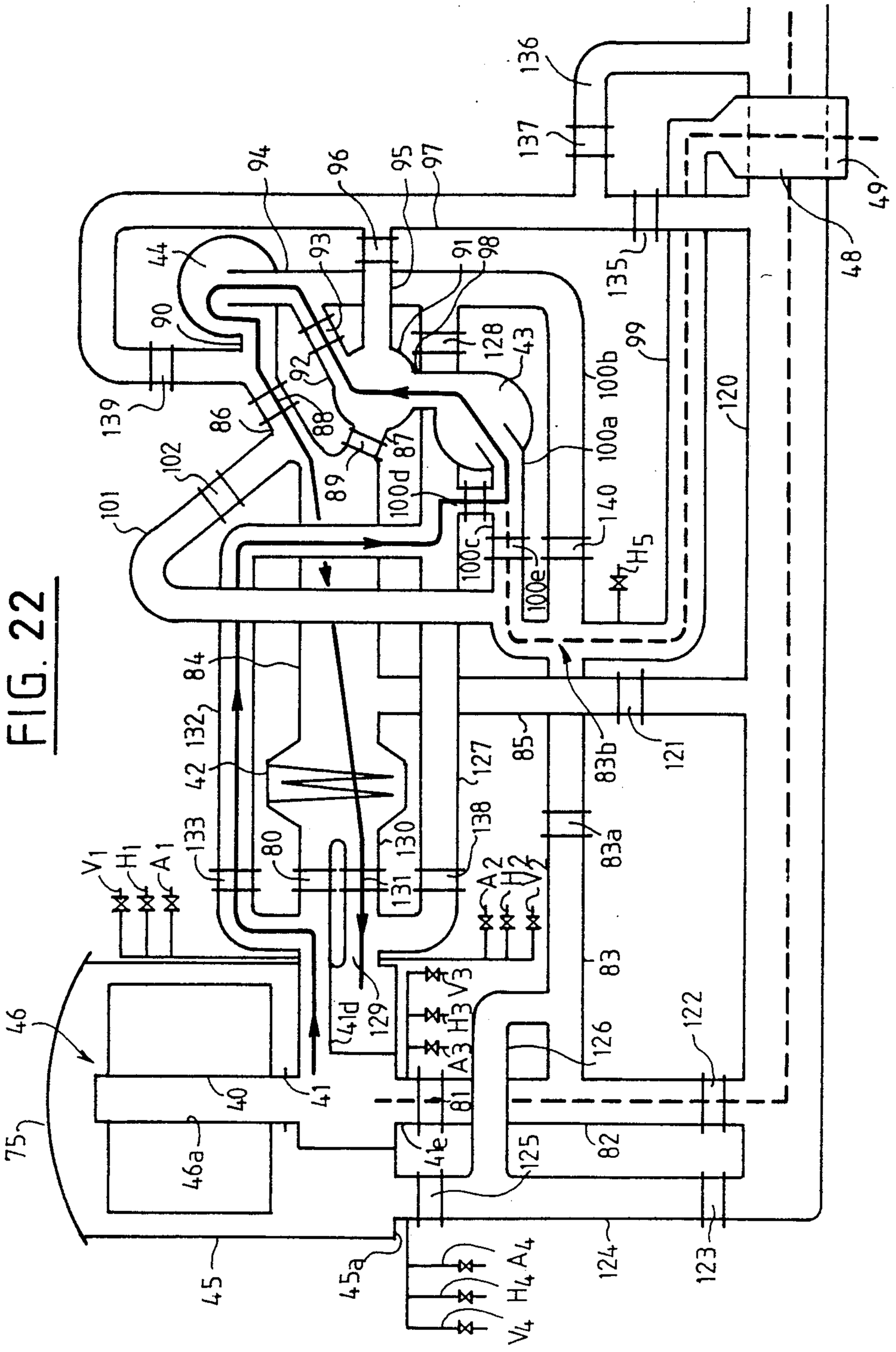
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FIG. 23

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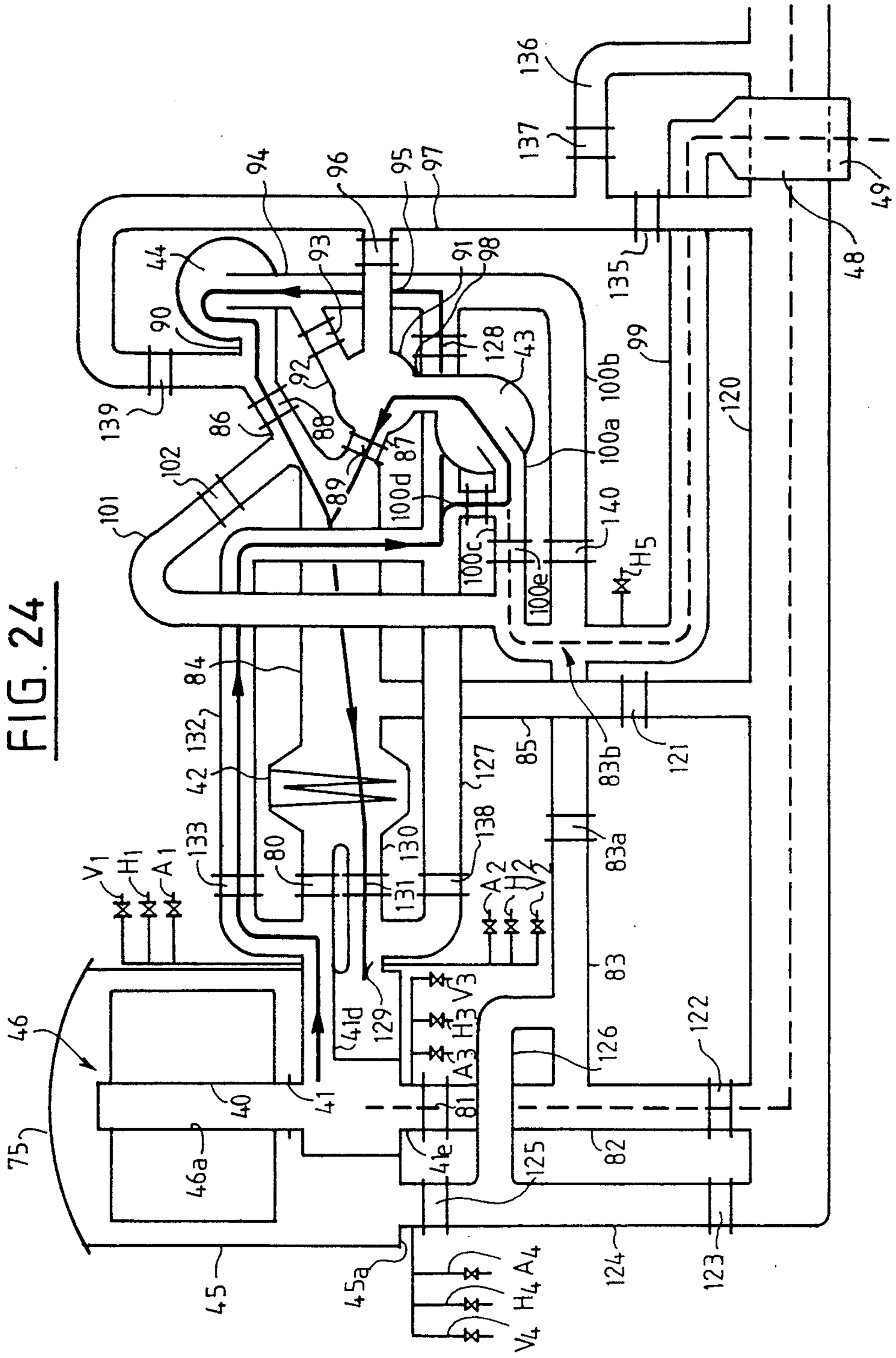
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METHOD AND INSTALLATION FOR REMOVING WATER FROM, DRYING AND/OR CONDITIONING FIBROUS, POROUS OR FILAMENT MATERIALS

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention relates to a method and installation for removing water from, drying and/or conditioning fibrous, porous or filament materials.

It applies to the removal of water from, to drying and/or conditioning of the most diverse fibrous materials, whatever form they take.

It applies, more particularly, to fibrous textile materials before spinning (in the form of flocks) during spinning (worsted yarns or tops), or after spinning (in the form of threads or filaments), as well as woven or knitted products.

The invention also applies to fibrous, porous or filament materials which are not textile materials such for example as non woven webs.

The invention is particularly well adapted to removing water from, drying and/or conditioning materials in the form of conical or cylindrical reels formed by winding a thread or filament on a perforated rigid or spring support or thread packets, that is to say volumes formed by winding threads or fibers without a support, or else yarns or filaments in the form of hanks.

2. Discussion of the Background

Water removal and drying installations are already known in which the two operations are carried out in one and the same enclosure, by forced air circulation through the material to be treated, alternately from the outside towards the inside and vice versa, with possible heating of the air at least during the drying phase.

The applicant has moreover already constructed such installations with or without a heat recovery device, whether this latter is of the air/water type, i.e. with production of hot water from the hot air leaving the dryer and which is cooled in said exchanger or of the air/air type, i.e. in which the hot air leaving the dryer is cooled while heating the incoming cold air, the heat being thus directly recovered from the dryer itself.

Other known installations, although they are satisfactory, are however generally provided for a specific use, both as to the materials to be treated are concerned and as to the treatment method and/or equipment, so that they do not have the characteristics of flexibility which are necessary at the present time, current practice requiring treatment of products of different natures and/or carrying out of a multiplicity of different treatments on the same material, or else using different treatment materials.

It is a general aim of the invention to provide a method for extracting water from, drying and/or conditioning fibrous, porous or filament materials as well as an installation for implementing such a method, in which the versatility is considerably increased, not only with respect to the different types of materials to be treated, but also to the different treatments which may be contemplated, or else to the equipment which may be used.

It is also an aim of the invention to provide a method and installation for implementing such a method which appreciably reduces the time for treating the materials while ensuring an excellent quality of the products obtained;

Finally, a further aim of the invention is to provide a method and installation for implementing such a method for carrying out the necessary treatments on fibrous, porous filament or similar materials, in a multiplicity of different modes, depending on the wound or packaged types of presentation of said materials and/or depending on the desiderata of practice for obtaining in each case the best possible results.

SUMMARY OF THE INVENTION

A method according to the invention for removing water from, drying and/or conditioning fibers, porous or filament materials, in which the water removal and drying operations are carried out in one and the same enclosure by forced air circulation, with possible heating thereof at least during the drying phase, is characterized in that:

a gaseous fluid stream is moved through an enclosure, using one or more flow means, so that it passes through the materials to be treated under a lowered and/or boosted pressure (over pressure), from the inside towards the outside of said materials, or vice versa,

a stream of water vapor is caused to pass through said materials so as to accelerate the removal of water at the beginning of drying and/or to rapidly raise the temperature of the treated materials, and/or to spray, if required, said materials during drying,

the drying air is humidified, if desired, by means of pressurized water, by spraying or by another humidification means,

if desired finishing products intended to be deposited on the materials to be treated are sprayed into the drying air; and

at the end of drying the materials are reconditioned, if desired by causing fresh ambient air to flow therethrough under a lowered and/or boosted pressure with or without addition of pressurized water, by spraying or by another humidification means.

Implementation of the method with circulation of a gaseous fluid under reduced pressure is particularly advantageous in that it lowers the boiling temperature of the water while maintaining a stream of gaseous treatment fluid, contrary to known embodiments in which the treatment enclosure is connected to a vacuum tank or to a vacuum pump.

In the case of causing a gaseous fluid to flow using a plurality of flow means, these flow means may be configured either in series or in parallel.

In the case, also, of the use of a plurality of flow means for causing the fluid to flow, said flow means are advantageously adapted so that at least one causes the gaseous treatment fluid to penetrate into the enclosure under increased pressure whereas at least one other of said means controls discharge of the fluid from the enclosure under reduced pressure.

Whatever the method of use, it is anticipated the compressed air may be introduced, if desired, into the gaseous fluid stream.

The method of the invention is particularly advantageous when applied to the treatment of hanks or similar volumes of material.

In such a case, the invention provides top to bottom and/or bottom to top flow of the gaseous treatment fluid through the suspended hanks.

An installation according to the invention, for removing water from, drying and/or conditioning fibrous,

porous or filament materials, comprising a single enclosure in which said materials are adapted to be placed, means for causing a gaseous fluid to flow through said materials as well as means for heating the drying air, is characterized in that the means for causing the gaseous fluid to flow are adapted so as to cause it to flow in the enclosure so that it passes through the material to be treated under a reduced and/or boosted pressure, from the inside towards the outside of said materials, or vice versa, and in that it comprises means for introducing water vapor into the gaseous fluid flow ducts for causing said vapor to pass through said materials so as to accelerate water removal at the beginning of drying and/or for rapidly raising the temperature of the materials during treatment and/or spraying said materials during drying, means for humidifying the drying air, means for spraying therein finishing products intended to be deposited on the treated materials and, if desired, compressed air injection means.

In one embodiment, the means for causing the flow of gaseous fluid comprise advantageously a plurality of means for causing forced flow of said fluid through the fibrous, porous, filament or similar materials during treatment.

In one embodiment, the means for causing forced flow of the fluid function in series.

In a variant, the means for causing forced flow of the fluid function in parallel.

In a preferred embodiment of the installation, the means for causing forced flow of the fluid, the ducts connecting said means to the enclosure as well as members for opening and/or closing said ducts, such as valves or the like, are organized so that the gaseous fluid passes through the materials to be treated under reduced pressure.

In the case of a plurality of flow means, they may act in series for discharging the gaseous fluid from the enclosure in which the gaseous fluid flows through the materials to be treated under reduced pressure.

In the alternative, the flow means may act in parallel for removing the gaseous fluid from the enclosure in which the fluid passes through the materials to be treated under a reduced pressure.

In either of these cases, the gaseous fluid flow may take place from the inside towards the outside of said materials to be treated.

In the alternative, in either or both of these cases, the gaseous fluid flow may take place from the outside towards the inside of said materials to be treated.

In one embodiment of the invention, in the case of a plurality of flow means, said means, the ducts connecting said means to the enclosure and the members for opening and/or closing said ducts are arranged so that the gaseous treatment fluid penetrates into the enclosure under increased pressure, under the action of at least one of said flow means whereas it is discharged from said enclosure under reduced pressure by at least another of said flow means.

In such an embodiment, the flow of the gaseous fluid may take place from the inside towards the outside of the materials to be treated.

In the alternative, the gaseous fluid flow may take place from the outside towards the inside of said materials.

The gaseous flow, in another alternative, may flow through the materials to be treated under increased pressure, whether the flow means act in series or in parallel, in the case of a plurality of flow means.

In accordance with the invention, and particularly for reconditioning the treated materials at the end of drying, the flow means, the ducts connecting said means to the enclosure as well as the members for opening and/or closing said ducts are arranged so that the gaseous fluid flow—which is then advantageously fresh ambient air with or without addition of pressurized water, by spraying or by another humidification means—takes place with partial or total recycling.

For this reconditioning phase, also, the gaseous fluid preferably passes through the materials to be treated under reduced pressure, from the inside to the outside, or vice versa.

In this case, a large amount of air passes through the materials to be treated before passing into the flow means, which means that the air can flow through the materials at ambient temperature and at ambient humidity .

In the case of a plurality of flow means, and also for this reconditioning phase, said flow means may act in series or in parallel.

In a preferred embodiment, the single treatment enclosure is provided with means for distributing the gaseous fluid introduced and/or removed from said enclosure through the materials to be treated, whether these materials are in the form of reels, in the form of thread packets, packages, flocks or similar volumes.

In another preferred embodiment, the installation is provided with means for treating yarns or filaments in the form of hanks.

In this case, and in particular when the hanks are suspended from material carrying bars, the flow of gaseous treatment fluid in the tank advantageously takes place from top to bottom through the suspended hanks.

In the alternative, and for certain types of yarns in hanks, the flow may take place in both directions, from top to bottom and from bottom to top.

Also in accordance with the invention, the enclosure in which the materials are placed for treatment thereof are provided with removable centering means, readily positioned for centering in said enclosure the material-carrying devices on which the materials are disposed prior to their treatment.

In one embodiment, these centering means are formed by bent rods which differ from each other by the length of a bent upper leg and which are adapted for cooperating with a ring and/or a circular sector fixed to the inside of the enclosure, at least the circular sector having holes for receiving ends of said rods and which are spaced apart in a plurality of concentric circles having decreasing diameters with increasing distance from the wall of the enclosure.

Material-carrying devices having differing structure or dimensions may thus be readily placed in the enclosure. Clamping, centering and locking means are provided on the removable cover and accommodate for differences in height and form of the fluid passage channels or the like of the material-carrying devices.

To this end also, on the one hand, sealing means are provided and, on the other, the means for distributing the gaseous treatment fluid inside the enclosure are so dimensioned such that the enclosure may accomodate all the desired material carriers.

Thus the sealing connection of the fluid flow channels or the like of the material carriers with those of the installation is guaranteed, as is the satisfactory required positioning of the material carriers in said enclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

A more complete appreciation of the invention and many of the attendant advantages thereof will be readily obtained as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings, wherein:

FIG. **1** is a general schematical view of an installation for extracting water from, drying, and/or conditioning fibrous, porous or filament materials in accordance with the invention;

FIG. **2** is a partial schematical view of a material carrier adapted to be used in an installation according to the invention;

FIG. **3** is a partial schematical view of an enclosure for receiving materials to be treated of an installation in accordance with the invention;

FIG. **4** is a view similar to that of FIG. **3**, for another part of the enclosure and for a variant;

FIG. **5** is a view similar to that of FIG. **4**;

FIG. **6** is a schematical view of an enclosure for receiving materials to be treated of an installation in accordance with the invention;

FIG. **6***a* is a detailed view;

FIG. **6***b* is a view similar to that of FIG. **6**, but for another embodiment; and

FIGS. **7** to **24** are diagrams of an installation according to the invention, similar to that of FIG. **1** and illustrating the flow of the fluids used.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Reference is made first of all to FIGS. **1** to **6***b* illustrating the structure of an installation according to the invention for removing water from, drying and/or conditioning fibrous or similar materials. It comprises a treatment tank **45**, generally cylindrical in shape, which may be sealingly closed at its upper part by a removable quick opening and closure lid **75**. Tank **45** is provided for housing a material carrier device **46** comprising, in a first embodiment and in a way known per se, a column **46***a* pierced with a multiplicity of orifices, not shown, allowing the gaseous fluid to pass between a longitudinal axial channel **40** in said column and the space inside tank **45**, the flow through the fibers, porous or filament material to be treated taking place from the outside towards the inside of the windings, supports or packages, or vice versa.

In another embodiment, FIG. **2**, the material carrier device **46** is in the form of a plate **46***b* on which are erected a plurality of columns **46***c* of smaller diameter than column **46***a* so that the gaseous fluid flowing through channel **40** is distributed in the columns **46***c* which carry, in stacked relation, the windings E of material to be treated in the form of threads or filaments disposed on their rigid perforated or spring supports, not shown, said windings being formed from threads, roves, combed tops, woven or knitted tops, knitted or woven wear.

In the case of knitted or woven wear the supports of the windings, depending on the case, are horizontal.

As shown in FIG. **3**, and both for the embodiment shown in FIG. **1** and for that shown in FIG. **2**, centering means are provided in tank **45** and formed for example, by a plurality of bent rods **50**, advantageously having circular cross sections, each being bent so as to form an upper leg **60** and a lower leg, an end of each upper leg **60** being further bent and received in perforations of an annular support **51***a* fixed to the side wall of tank **45** at the top part thereof. The lower ends of the lower legs of the rods **50** are respectively introduced into one of a plurality of holes **51***b* of a circular sector **51***c* also fixed to the internal side wall of the tank **45**, spaced from the ring **51***a*. The holes **51***b* are spaced apart in a plurality of concentric circles of diameters that decrease with increasing distance from the wall of the tank so that when the rods **50**, which differ from each other by the lengths of their upper legs **60**, are positioned on the ring **51***a* and on sector **51***c*, a structure is obtained somewhat similar to a squirrel cage for centering the material carriers **46** of different diameters, as shown in the right and left hand parts of FIG. **3**.

At a distance from the bottom **45***a* of tank **45** there opens into this latter, as shown at **41**, a distribution member **41***a*, FIGS. **4**, **5** and **6**. In the embodiments of FIGS. **1** and **4**, said distribution member **41***a* has dimensions similar to those of column **46***a*, so that, after the positioning and centering of the material carrying device in the tank, the channel **40** of column **46***a* extends the channel **41***b* of the distribution member **41***a* for forming a continuous gaseous fluid passage intended to pass through the fibrous, porous, filament and/or similar materials being treated.

A seal **41***c* is provided, if necessary, at the junction of channels **40** and **41***b*.

In the embodiment of FIGS. **5** and **6**, the diameter of the distribution member **41***a* is larger than that of column **46***a*, so that material carriers having columns **46***a* of different dimensions may cooperate with said distribution member, provided that the longitudinal channel **40** of said columns has a diameter less than that shown at **41***b* of member **41***a*.

Sealing means **41***c* may be provided, FIGS. **5** and **6**. For providing good sealing with respect to the gaseous fluids flowing in the distribution member **41***a* and in channel **40**, the invention provides complementarily FIGS. **6** and **6***a*, a device **70** mounted on the lid **75** of tank **45**. The device **70** comprises a hand wheel **70***a* which drives a rod **72** which cooperates with the head **71***a* of an assembly **71** associated with a material carrier **46** for applying a clamping force for forcing said material carrier against the sealing means **41***c*.

Assembly **71** also comprises, as can be clearly seen in FIG. **6***a*, a lifting ring **73** and, on each side of a centering pin **74**, hooks **175** mounted for pivoting about a shaft **76** against the action of spring **77** and adapted for cooperating with studs **78** integral with the material carrier for removable locking thereof.

In the embodiment shown in FIG. **6***b*, designed more particularly in accordance with the invention for treating materials in the form of hanks, the material carrier is provided with bars **150** from which the hanks Ex are suspended and column **46***a* is extended at its upper part by a perforated extension **47** extending between a solid end plate **48** and a lower plate **49**, also perforated, for letting the gaseous treatment fluid flow therethrough along the path shown by the arrow g, that is to say through channel **40**, extension **47**, plate **49** and the hanks Ex disposed on the bars **150** placed on the plate **49**. With these preceding arrangements, tank **45** may receive material carriers which differ from each other by their diameter, their height or else the dimensions of column **46***a* and of the longitudinal channel **40**, so that the installation of the invention is thus made versatile in this respect.

The installation further comprises, joined end to end with the distribution member **41***a*, a duct **41***d* and a duct **41***e*, the first one being connected through a valve **80** or the like to a heat generator **42**, whereas the second duct **41***e* is connected through a valve or the like to a duct **82** into which is tapped a duct **83** which, beyond a valve **83***a* or the like, leads to a connection **83***b* of ducts which will be described hereafter.

The heat generator **42** may be a heat exchanger fed with vapor or a heat exchanger fed with a heat carrying fluid, such as superheated water, or else may be in the form of an electric heating means, or in the form of a gas burner with direct heating, or else in the form of a gas heater with indirect air heating.

Whatever the embodiment chosen, the heat generator **42** is connected, at the end opposite the one connected to duct **41***d*, to a duct **84** into which a duct **85** opens and which, at its end opposite that connected to the heat generator **42**, is divided into branches **86** and **87**. The first branch **86** is connected through a valve **88** or the like to an outlet duct **97** having a valve **139** and also is connected to the outlet pipe **90** of an air flow means **44**, for example a booster, a fan, a compressor or the like. The second branch **87** is connected through a valve **89** or the like to a distributor **91**. To the distributor **91** are connected a duct **92**, a duct **95** and an outlet duct **98** of a second flow means **43**, similar to air flow means **44**. The duct **92** communicates through a valve **93** or the like with an intake pipe **94** of the air flow means **44**. The duct **95** communicates through a valve **96** or the like with the duct **97**.

In a variant, not shown, the installation comprises not only two air flow means but a plurality of such means.

The intake of air into the installation is made through a filter **49** for removing impurities, a heat exchanger **48** adjacent said filter being provided for recovering the heat from the outgoing air by heating the incoming air.

The outlet **99** of the filter-exchanger assembly is connected to the connection **83***b* from which extend an intake duct of **100***a* of the air flow means **43** and a duct **100***b* connected to the intake pipe **94** of the air flow means **44**, with interpositioning in said duct **100***b* of a valve **140** or the like. Form connection **83***b* there also extends a duct **101** having a valve **102** or the like. Duct **101** opens into duct **86** so that the air coming into the installation may be conveyed either by ducts **99**, **100***b* and **94** to the inlet of the flow means **44**, or through ducts **99** and **100***a* to the inlet of the flow means **43**, or else through ducts **99** and **101** to the heat generator **42**, or finally, from duct **100***a* and a bypass **100***c* provided before the inlet into the flow means **43** and in which is inserted a valve **100***d*, simultaneously to the air flow means **43** and **44**.

The heat exchanger **48** is connected to an air outlet duct **120**, which may be placed in communication by a valve **121** or the like, on the one hand, with duct **85** connected to the heat generator **42** and, on the other hand, through valves **122** and **123** or the like, respectively, with duct **82** which is connected, through the distribution member **41***a*, to the channel **40** of column **46***a* of the material carrier and to a duct **124** in which is inserted a valve **125** or the like connecting said duct to the bottom **45***a* of the treatment tank **45**.

As can be seen in FIG. **1**, the installation also comprises a duct **126** between duct **124** and duct **83**, as well as a duct **127** connecting, through a valve **138** or the like, the inside of tank **45** either with duct **100***c* or, through a valve **128**, to pipe **94**, said duct **127** being mounted in parallel, from the outlet **129** of tank **45**, with another duct **130** which is connected to the heat generator **42** through a valve **131**.

A duct **132** in which is inserted a valve **133** also connects duct **41***d* to duct **127**. Duct **97** is connected to duct **120** upstream of the heat exchanger **48**, the same duct **97** gain being connected to the same duct **120**, downstream of the heat exchanger **48**, by a duct **136**. The communication of duct **97** and duct **120** at the upstream side of the heat exchanger is governed by the opening and/or closing of a valve **135** or the like, whereas in duct **136** is inserted a valve **137** or the like.

Also in accordance with the invention, means V_1, V_2, V_3 and V_4 are provided connected to the pressurized vapor generator for introducing vapor into the installation and, more precisely, in duct **41***d* for device V_1, in duct **127** for device V_2, in duct **41***e* for device V_3 and in duct **124** for device V_4.

Similarly, devices referenced respectively H_1, H_2, H_3, H_4 and H_5 are provided for introducing pressurized and sprayed water into the installation, devices H_1, H_2, H_3, H_4 being placed in correspondance with the devices V bearing the same indices, whereas device H_5 allows pressurized and sprayed water to be introduced into the duct **99** intaking air into the installation, downstream of the heat exchanger **48**, in the flow direction of the gaseous fluid.

Finally, an assembly of devices A_1, A_2, A_3, A_4 open into the ducts of the installation in correspondence with the devices V and H bearing the same indices and allow pressurized and sprayed finishing products such as oiling products to be added to the gaseous treatment fluids. Means, not shown, are provided for introducing compressed air into the ducts.

An installation such as described above may be used in different ways, depending on the final desired effect of the treatment, by modifying the flow conditions of the gaseous fluids as well as by a choice of the characteristics of said fluids charged or not with conditioning and/or reconditioning products.

In what follows, there will be described by way of non limitative example several methods of using the installation with reference to FIGS. **7** to **24**, in which the path of the gaseous fluids is shown by arrowed lines.

EXAMPLE 1

In this example, FIG. **7**, a single air flow means is used, namely means **43** for causing the air coming into the installation to flow through the filter **49** along a path going, under increased pressure, from the inside to the outside of the material to be treated, whether the windings are on reels or in the form of packets.

In this example, the air flow from the heat exchanger **48** takes place through duct **99**, duct **100***a*, the flow means **43**, branch **87**, duct **84**, the heat exchanger **42** at the outlet of which the air penetrates into duct **41***d* then, through channel **40**, where it passes through the material to be treated before escaping, through valve **125**, into duct **124** from which it reaches the outlet duct **120** through the valve **123**.

EXAMPLE 2

In this embodiment, FIG. **8**, the flow of gaseous fluids takes place from the inside to the outside of the windings of material to be treated, as in the preceding example, however not under an increased pressure but by suction, that is to say that the fluid passes through the material under reduced pressure.

From the heat exchanger **48** the gaseous fluid flows through ducts **99**, **101**, branch **86**, duct **84** through which it penetrates into the heat generator **42** then, through channel **40**, into the material to be treated at the outlet of which it leaves the treatment tank through orifice **129**, is taken up by duct **127** after passing through valve **138**, duct **100***c*, the intake pipe **100***a* of the flow means **43**, distributor **91**, duct **97** and, through valve **135**, as far as the outlet duct **120**.

EXAMPLE 3

In this case, FIG. **9**, the gaseous fluid flows through the material to be treated from the outside of the windings to the inside thereof, the path then being defined from the heat exchanger **48** through duct **99**, the intake pipe **100***a* of the flow means **43**, distributor **91**, branch **87**, duct **84** leading the gaseous fluid through the heat generator **42**, the inlet into the treatment tank **45** through duct **130** and valve **131** as far as opening **129**. After passing through the material to be treated from the outside to the inside of the windings, the gaseous fluid passes through channel **40** and leaves the treatment tank through duct **41***e*, valve **81**, duct **82**, valve **122** and finally duct **120**.

EXAMPLE 4

In this application, FIG. **10**, the gaseous fluid flows through the material to be treated from the outside to the inside but, contrary to the application of example **3**, under a reduced pressure and not an over pressure.

The path of the gaseous fluid, from the heat exchanger **48**, is then that comprising duct **99**, duct **101**, branch **86**, the inlet duct **84** of the heat generator **42**, duct **130** bringing hot air inside tank **45** and on the outside of the material to be treated. When the gaseous fluid has passed through the material and has penetrated into channel **40**, it is then removed through valve **133**, duct **132**, valve **100***d*, duct **100***c* and the intake pipe **100***a* of the flow means **43** from where it leaves as in example 2.

EXAMPLE 5

In this mode of use, FIG. **11**, the invention uses not just a single air flow means but two air flow means, simultaneously and in series, for causing the gaseous fluid to pass through the material to be treated from the inside towards the outside under an over pressure.

After passing through the heat exchanger **48** the fluid is brought by ducts **99** and **100***a* into the first flow means **43** then, through distributor **91** and pipe **92**, to the intake pipe **94** of the second flow means **44**. The outlet from this latter is through pipe **90** and branch **86** from where the fluid penetrates into duct **84**, passes through the heat generator **42** and reaches channel **40** through valve **80** and duct **41***d*.

After passing through the material to be treated from the inside towards the outside of the windings, the gaseous fluid leaves tank **45** through valve **125**, duct **124**, valve **123** and duct **120**.

In a variant, by opening valve **83***a*, a bypass of the outgoing fluid is established using duct **126** so that, as shown with a broken line in FIG. **11**, the bypassing fluid arrives at the branch **83***b*, thus defining a recycling operational mode.

EXAMPLE 6

In this mode of operation, and as in the preceding example, the two fluid flow means **43** and **44** are operational in series, FIG. **12**.

On the other hand, and as opposed to example 5, suction is used here, the fluid path being formed from the heat exchanger **48**, through duct **99**, duct **101**, branch **86**, duct **84**, heat generator **42**, duct **41***d*, channel **40**. From this latter, the gaseous flow passes through the materials to be treated from the inside to the outside of the windings, then escapes from tank **45** through orifice **129**, duct **127**, duct **100***c*, the intake pipe **100***a* of flow means **43**, distributor **91**, the intake pipe **94** of the second flow means **44** then leaves this latter through duct **90**, valve **139**, duct **97** and the discharge duct **120** after passing through valve **135**.

In a variant, and as shown with a broken line at the right hand part of FIG. **12**, the invention also provides, by opening valve **137**, complementary discharge through duct **136**.

EXAMPLE 7

In this mode of operation, the two fluid flow means **43** and **44** are no longer operational in series but in parallel, FIG. **13**.

At the outlet of the heat exchanger **48**, the treatment air flows through duct **99**, the inlet duct **100***a* of the air flow means **43** and simultaneously duct **100***c* leading to the intake pipe **94** of the flow means **44** so that the outlets from means **43** and **44** through branches **87** and **86**, respectively, join up in the inlet duct **84** to the heat generator **42**. The gaseous flow leaves said generator through duct **41***d*, penetrates into channel **40**, passes through the windings to be treated from the inside towards the outside and leaves the tank **45** through valve **125** and duct **124**, similarly to what was described above for example 5.

As in said example, a part of the gaseous fluid leaving tank **45** may be directed through duct **126**, then duct **123**, valve **140** and duct **100***b* for partial recycling.

EXAMPLE 8

Whereas in the preceding example the flow means **43** and **44** are used for treatment under over pressure in the example now considered, FIG. **14**, they are used for obtaining treatment by suction and in a parallel assembly as in the preceding example.

The path of the gaseous fluid then comprises, from the heat exchanger **48**: duct **99**, duct **101**, the inlet duct **84** into the heat generator **42**, the inlet duct **41***d* into channel **40**, passing through the materials to be treated from the inside to the outside, then leaves the tank through orifice **129**, duct **127**, duct **100***c*, the inlet pipe **100***a* of the flow means **43** and simultaneously the intake pipe **94** of the flow means **44**, the outlets from said flow means both discharging into duct **97** then into the outlet duct **120**, FIG. **14**.

As in example 6, a partial bypass of the outlet may be made through duct **136**.

EXAMPLE 6

In this embodiment, FIG. **15**, which uses the two flow means **43** and **44** in a series assembly, the path of the gaseous fluid from the heat exchanger **48** to the inlet of the heat generator **42** is identical with that of example 5.

In the present example however, the outlet from the heat generator **42** is not through duct **41***d* but through duct **130** so that the gaseous fluid penetrates inside tank **45** and passes through the windings to be treated from the outside towards the inside. The fluid is then discharged from channel **40** through valve **81**, duct **82**, valve **122** and duct **120**.

As in example 5, partial recycling may be obtained by directing a certain amount of the fluid leaving the tank through duct **83**, the path of the thus recycled fluid being shown with a broken line in FIG. **15**.

EXAMPLE 10

In this operating mode, FIG. **16**, provided for causing the gaseous fluid to flow through the windings to be treated from the outside towards the inside, said fluid flow means **43** and **44** operate in series and exert a suction effect.

The path of the gaseous fluid is then as shown in FIG. **16**, that is to say identical to that of example 6 between the heat exchanger **48** and the inlet into the heat generator **42**, the outlet from said generator being however through duct **130** and not through duct **41***d* as in example 6.

After passing through the material to be treated the gaseous fluid leaves tank **45** through duct **132**, flows through valve **100***d*, passes through the intake pipe **100***a* into the flow means **43**, leaves this means through duct **98** and reaches the intake pipe **94** of the flow means **44**, discharge from this flow means **44** being provided, because of closure of valve **88**, through duct **90** leading to the outlet duct **120**.

As in the examples 6 or 8, a bypass outlet through duct **136** may also be provided, the path of which is shown with a broken line in FIG. **16**.

EXAMPLE 11

Flow of the treatment fluid is provided under over pressure from the outside towards the inside of the windings using a parallel assembly of the flow means **43** and **44**, FIG. **17**.

In this example, the path of the gaseous fluid from the heat exchanger **48** and as far as the inlet of the heat generator **42** is as in example 7.

Contrary to that example, however, the outlet from heat generator **42** is not through duct **41***d*, the gaseous fluid penetrating into the tank **45** through orifice **129** and leaving said tank through channel **40**, through valve **81** and channel **82** to the outlet duct **120**.

As in the operating mode of example 7, opening of valve **83***a* causes a certain amount of fluid to be taken from tank **45** and fed to the intake pipe **94** of the flow means **44**, that is to say operation with partial recycling, FIG. **17**.

EXAMPLE 12

In this operating mode, illustrated in FIG. **18**, the gaseous fluid is caused to pass through the windings of material to be treated, from the outside towards the inside, with suction, that is to say under reduced pressure through the material and with flow means acting in parallel.

From the heat exchanger **48** and as far as the inlet of the heat generator **42** the path of the fluid is identical to that of example 8 but, as opposed to that example, the outlet from the heat generator **42** is through valve **131**, so that the gaseous fluid penetrates into tank **45** through orifice **129**.

After passing through the material to be treated, the gaseous fluid leaves tank **45** through duct **41***d*, duct **132** and, from the junction of said duct with duct **127**, follows the same path as that in example 11, that is to say a first stream is processed by the fluid flow means **43** whereas a second stream is processed by the fluid flow means **44**, the outlet from said two means arriving in duct **97**.

EXAMPLE 13

In this operating mode, the treatment is effected by causing the gaseous fluid to flow through the material to be treated from the inside towards the outside of the windings with, simultaneously, suction and over pressure, FIG. **19**.

To this end, the gaseous fluid from the heat exchanger **48** is fed by duct **99** to the intake pipe **100***a* of the flow means **43**. At the outlet of this latter, with valve **89** then open in the flow direction from distributor **91** to the heat generator **42**, the gaseous fluid flows through said generator and penetrates into tank **45** through duct **41***d*. It then flows through channel **40**, through the material to be treated and leaves the tank through orifice **129**. Through duct **129** the gaseous fluid reaches the intake pipe **94** of the flow means **44** from which it leaves through duct **90** then duct **97**, which is connected to duct **120** upstream and/or downstream of the heat exchanger **48**.

EXAMPLE 14

In this operating mode, FIG. **20**, somewhat similar to the one described immediately above, the invention also provides for the simultaneous use of suction and over pressure.

However, contrary to the preceding example, the gaseous fluid is caused to flow so that it passes through the windings of material to be treated from the outside towards the inside, that is to say that the path of the fluid in this example is identical to the one of the preceding example for the part included between the heat exchanger **48** and the heat generator **42**. However, instead of penetrating into the tank through duct **41***d*, the intake is through orifice **129**, the outlet then being through duct **41***d*, duct **132**, valve **128**, the intake pipe **94** of the flow means **44** then the outlet from said means through valve **139** and duct **97**.

As shown with full and broken lines in FIG. **20**, the gaseous treatment fluid joins duct **120** upstream of the heat exchanger **48** and/or also downstream thereof, depending on the case.

EXAMPLE 15

In this operating mode, FIG. **21**, the gaseous fluid is caused to flow by the two means **43** and **44**, for passing through the windings of material to be treated from the inside towards the outside.

In this operating mode, however, a first embodiment does not use an intake of air through the heat exchanger **48**, so that the flow is in a closed circuit, that is to say with total recycling.

As shown by the continuous line arrows in FIG. **21**, the air which penetrates into tank **45** through duct **41***d* and, from there, reaches channel **40**, passes through the windings of material to be treated from the inside towards the outside and leaves tank **45** through orifice **129**, duct **137**, the intake pipe **100***a* of the flow means **43**, distributor **91**, valve **93**, the intake pipe **94** of the flow means **44**, the outlet from this means then being through

valve **88**, returning to the heat generator **42** from which it then leaves through duct **41***d*.

In a variant, and as shown with broken lines, valve **100***e*—upstream of the intake pipe **100***a* of the flow means **43**—is open—whereas it was closed in the preceding conditions—so that a certain amount of air may be introduced into the circuit, the treatment then being with partial recycling.

EXAMPLE 16

In this operating mode, closely related to that of the preceding example, the flow of gaseous fluid takes place from the outside to the inside through the windings of material to be treated, as shown by the continuous line arrows in FIG. **22**.

The fluid then enters tank **45** through orifice **129**, connected to the outlet of the heat generator **42** and the fluid leaves said tank through duct **41***d*, duct **132**, valve **100***d*, the intake pipe **100***a* in the flow means **43**, distributor **91**, the intake pipe **94** in the flow means **44**, valve **88** with return through duct **84** into the heat generator **42** from which the gaseous fluid again penetrates into the treatment tank.

As in the preceding example, instead of the above described operating mode which is with total recycling, another mode of operation may be used, when valve **100***e* is momentarily open. Similarly, to the embodiment of example 15, where a partial fluid outlet may be provided through valve **125** and duct **124** in example 16 an outlet is provided through valve **81** and duct **82**.

EXAMPLE 17

In this operating mode, the gaseous fluid flow means **44** are mounted in parallel, FIG. **23**.

In a first condition valve **100***e* is closed, the gaseous treatment fluid penetrates into tank **45** through duct **41***d*, channel **40**, passes through the windings of material to be treated from the inside towards the outside, leaves tank **45** through orifice **129** and is brought by duct **127**, on the one hand, to the intake pipe **100***a* of the flow means **43** and, on the other hand to the intake pipe **94** of the flow means **44**. The outlets from means **43** and **44**, through branches **87** and **86**, respectively, join up in duct **84** leading to the heat generator **42** the outlet from which through duct **41***d* reintroduces the gaseous fluid, with total recycling, into the tank **45**.

In a variant, illustrated with broken lines, the recycling is only partial; with valve **100***e*, a certain amount of air is admitted from the heat exchanger **48**, whereas with valve **125** also open a certain amount of air may be removed from tank **45** through duct **124** and valve **123** as far as duct **120**.

EXAMPLE 18

In this operating mode, similar to the one described immediately above, the flow of gaseous fluid is from the outside towards the inside of the windings of material to be treated.

The introduction of gaseous fluid into tank **45** takes place consequently through orifice **129**, at the outlet of the heat generator **42**, whereas the outlet from said tank is through duct **41***d*, duct **132**, the intake pipe **100***a* of the flow means **43** and simultaneously the intake pipe **94** of the flow means **44**, the outlets from said two means being brought together through branches **87** and **86**, respectively, to reach duct **84** and the heat generator **42**, from which the fluid leaves through orifice **129** as indicated above.

In this embodiment, also, partial recycling may be obtained when, on the one hand, valve **100***e* is open and when, on the other hand, a part of the gaseous fluid is discharged through valve **81** into duct **82** and into duct **120**, FIG. **24**.

The installation of the invention may treat fibrous, porous or filament materials in a multiplicity of operating modes whether said materials are in the form of hanks, wound thread, roves, combed tops, woven or knitted tops, knitted or woven wear.

Thus, for removing water from the volumes of material to be treated, whether they are in the form of windings or packages, a pressurized water vapor flow is provided, being introduced into the installation by actuating devices V_1–V_4, either through the inlet of tank **45** into duct **41***d* or into duct **130**, in the vicinity of orifice **129**, or else into ducts **82** or **124**. The flow of the vapor through the material may take place either under the effect of the vapor pressure itself, or by using the under pressure or the over pressure of the flow means **43** and/or **44** with or without air intake.

After removal of water, when the windings or packages of material to be treated are still heavily impregnated with water, and so not very permeable to the flow of gaseous fluid, particularly at the beginning of the drying treatment, operation is as shown in examples 5 or 9, that is to say by operating the two flow means in series for an over pressure operation.

As soon as the permeability of the material to be treated is sufficient, the installation is caused to operate as described with reference to example 7 (FIG. **13**) or to example 8 (FIG. **14**), that is to say also with the two fluid flow means, but this time with parallel assembly.

On the other hand, for materials likely to undergo deformations such as felting or tangling or during a high rate gaseous fluid flow rate, the invention provides, from a certain humidity rate, for the use not of the two flow means but of a single one, for example as described in examples 1 to 4, and with reference to FIGS. **7** to **10**.

Both in the case of using one or two gaseous fluid flow means, the invention provides advantageously a suction operating mode, examples 2, 4, 6 and 10, by placing under reduced pressure a part of the material to be treated, that is to say with lowering of the vapor tension and or the temperature of said material.

Drying, carried out at this lower temperature, preserves the intrinsic qualities of certain textile materials, such as shrinkage, feel, fullness, etc . . .

Furthermore, the fact of treating at a lower temperature than that generally used reduces entirely or partly the risks of migration of the dyes or of the finishing products deposited on the material, such migration taking place from the damper parts towards the drier parts and being promoted by the high temperatures of the drying air.

The risks of yellowing are also reduced in this way, in the case of fibrous textile materials, which yellowing is promoted by the high temperatures of the drying air, in particular for bleached materials or materials tinted with light colors.

The presence of devices A and H considerably increases the possibilities of use of the installation of the invention for conditioning fibrous materials, particularly textile materials.

In fact, by means of devices A, one or more finishing products may be introduced into the fluid flow ducts for depositing on the treated material so as to confer thereon the desired quality. The finishing product may,

for example, be a softener or lubricant for improving the feel or for facilitating subsequent use of the material during weaving, knitting or during use, for example for sewing thread.

Devices H, by means of which the invention introduces pressurized water and/or with spraying into the gaseous treatment fluid, contribute to obtaining satisfactory and rapid conditions and/or reconditioning.

It is in effect known that for textile materials, in particular, there exist relative humidity rates considered as optimum and which vary from one fiber to another. Thus, for cotton, such a rate is of the order of 7 to 8%, whereas it is of the order of 16% for wool. Now, at the end of the drying operations, it frequently happens that this relative humidity rate is less than the optimum value, for example of the order of 1 to 2% at the end of treatment of cotton fibers.

Whereas the usual conditioning techniques consist in exposing the treated material to the ambient air for progressively returning it to its natural balanced state, this procedure is both relatively long and non uniform. For example, non-uniformity between the inside and outside the volumes of treated material causes defects of homogeneity and delays in use detrimental in modern high productivity factories.

This is why, according to the invention, fresh ambient air is caused to flow through the treated material with or without addition of pressurized water, by spraying, introduced through devices H, or with any other means for humidifying the air introduced by devices H, with or without recycling, so as to bring the relative humidity rate of the treated material to a value close to the optimum conditioning rate, this flow being carried out with the heat exchanger **48** made momentarily inoperative and following the operating modes of examples 15 to 18, FIGS. **21** to **24**, without this indication having any limiting character whatsoever.

In the foregoing, the method and installation have been described for a vertical treatment tank in which the material carrier is also vertical.

It goes without saying that the invention also applies, except for the treatment of hanks, to a method or installation in which the treatment tank is horizontal, the material carrier being disposed correspondingly.

Obviously, numerous additional modifications and variations of the present invention are possible in light of the above teachings. It is therefore to be understood that within the scope of the appended claims, the invention may be practiced otherwise than as specifically described herein.

What is claimed is:

1. A method of using a single enclosure to treat fibrous, porous or filament materials contained therein with a flow of gaseous fluid, said method comprising the steps of:

providing a single enclosure adapted to contain material to be treated;

introducing material to be treated into the enclosure;

making a first determination of whether it is desired to treat the materials during a drying phase under a reduced pressure condition of the flowing gaseous fluid or under an over pressure condition of the gaseous fluid;

making a second determination of whether it is desired to cause the gaseous fluid to flow through the material in a direction from an inside portion of the material toward an outside portion of the material or in a direction from an outside portion of the material toward an inside portion of the material or in a vertical direction through the material;

making a third determination of whether or not is is desired for the gaseous fluid to be in a heated thermal condition or in a non-heated thermal condition during said drying phase;

making a fourth determination of a desired humidity condition of the gaseous fluid during said drying phase by determining whether or not it is desired to introduce humidity into the gaseous fluid during said drying phase;

making a fifth determination of a desired composition of the gaseous fluid by determining whether or not it is desired to introduce a finishing product into the gaseous fluid for deposition on the material in the enclosure;

conducting said drying phase by causing a stream of gaseous fluid to flow through the material in the enclosure and, during said flow, establishing a pressure condition of the flow in accordance with said first determination, establishing a flow direction through the material in the enclosure in accordance with said second determination, establishing a thermal condition of the flow in accordance with said third determination, establishing a humidity condition of the flow in accordance with said fourth determination, and establishing a composition of the gaseous flow in accordance with said fifth determination;

making a sixth determination of whether or not it is desired to follow the drying phase with a reconditioning phase;

if said sixth determination is positive, making a seventh determination of whether it is desired to conduct said reconditioning phase under a reduced pressure condition or under an over pressure condition;

if said sixth determination is positive, making an eighth determination of a desired humidity condition by determining whether or not it is desired to introduce humidity during said reconditioning phase;

if said sixth determination is positive, causing a stream of fresh ambient air to flow through the material in the enclosure and, during said flow, establishing said pressure condition and said humidity condition in accordance with said seventh and eighth determinations, respectively.

2. A method as claimed in claim **1**, wherein at least one of said steps of causing a gaseous fluid to flow through the material to be treated comprises the steps of using a plurality of flow means to cause said flow and of moving said fluid through said flow means in series.

3. A method as claimed in claim **1**, wherein at least one of said steps of causing a gaseous fluid to flow through the material to be treated comprises the steps of using a plurality of flow means to cause said flow and of moving said fluid through said flow means in parallel.

4. A method as claimed in claim **1**, wherein at least one of said steps of causing a gaseous fluid to flow through the material to be treated comprises the steps of using at least one flow means to deliver the gaseous fluid to the enclosure under an over pressure and using at least one additional flow means to remove the gaseous fluid from the enclosure under reduced pressure.

5. A method as claimed in claim **1**, further comprising the step of introducing compressed air into the flow of gaseous fluid.

6. A method as claimed in claim 1, wherein said step of introducing material to be treated into the enclosure comprises the step of providing in the enclosure a plurality of suspended hanks of material to be treated.

7. A method as claimed in claim 6, wherein said step of making a second determination comprises the step of determining that it is desired for the gaseous fluid to flow in a vertical direction through the suspended hanks.

8. An installation for drying or conditioning fibrous, porous or filament materials comprising:

a single enclosure adapted to contain material to be treated and having means creating a fluid flow path therethrough, a portion of said fluid flow path of said enclosure extending between an interior portion of the material to be treated and an exterior portion of the material to be treated;

ductwork and a plurality of fluid valving means therein for handling a gaseous fluid, said ductwork being in communication with said flow path of said enclosure;

flow means connected to said ductwork for causing the gaseous fluid to move therethrough;

heating means connected to said ductwork and being selectively operable to heat the gaseous fluid flowing therethrough, said ductwork, valves and flow means comprising means for selectively:

moving the gaseous fluid through said heating means and for forcing the gaseous fluid under an over pressure in a first direction through said flow path of said enclosure,

moving the gaseous fluid through said heating means and for forcing the gaseous fluid under an over pressure in a second direction through said flow path of said enclosure,

moving the gaseous fluid through said heating means and for moving the gaseous fluid under reduced pressure in said first direction through said fluid flow path of said enclosure, and

moving the gaseous fluid through said heating means and for moving the gaseous fluid under reduced pressure in said second direction through said fluid flow path of said enclosure,

wherein said installation further comprises means for selectively introducing water vapor into said ductwork, means for selectively spraying water into said ductwork, means for selectively spraying a material finishing product into said ductwork, and means for selectively introducing compressed air into the gaseous fluid.

9. An installation as claimed in claim 8, wherein said flow means comprise a plurality of flow means.

10. An installation as claimed in claim 9, comprising means for connecting said plural flow means in series for said moving of the gaseous fluid under reduced pressure through said fluid flow path of said enclosure.

11. An installation as claimed in claim 9, comprising means for connecting said plural flow means in parallel for said moving of the gaseous fluid under reduced pressure through said fluid flow path of said enclosure.

12. An installation as claimed in claim 9, comprising means for connecting said plural flow means for passing the gaseous fluid through said enclosure under reduced pressure and so that at least one of said flow means passes the fluid to said enclosure and at least one of said flow means removes the gaseous fluid from the enclosure.

13. An installation as claimed in claim 9, comprising means for connecting said plural flow means in parallel for said moving of the gaseous fluid under an over pressure through said fluid flow path of said enclosure.

14. An installation as claimed in claim 9, comprising means for connecting said plural flow means in series for said moving of the gaseous fluid under an over pressure through said fluid flow path of said enclosure.

15. An installation as claimed on claim 8, comprising means for recirculating the gaseous fluid in a closed path through said flow means, heating means and enclosure, and means for selectively withdrawing some of said gaseous fluid from said closed path.

16. An installation as claimed in claim 8, wherein said flow means comprise a plurality of flow means, further comprising means for selectively connecting said plural flow means in series or in parallel.

17. An installation as claimed in claim 8, further comprising distribution means disposed in said single enclosure for distributing the gaseous fluid through the material to be treated.

18. An installation as claimed in claim 8, further comprising centering means disposed in said enclosure for cooperating with a carrying device for the material to be treated to center the carrying device in said enclosure, said centering means being removably received in said enclosure.

19. An installation as claimed in claim 18, wherein said centering means comprise a plurality of rods, each rod being bent to form an upper leg and a lower leg, said rods having upper legs of different lengths, further comprising means fixed inside said enclosure for removably receiving said upper legs of a plurality of said bent rods and a circular sector fixed inside said enclosure and spaced from said ring for removably receiving said lower legs of said bent rods, there being a plurality of holes formed in said circular sector and disposed in a plurality of concentric circles, said lower legs being received in said holes.

20. An installation as claimed in claim 8, further comprising a material holder having means for suspending a plurality of hanks, said flow path of said enclosure including a portion providing vertical flow through said suspending means.

21. An installation as claimed in claim 8, further comprising a material carrier for the material to be treated and means for clamping, centering and locking said material carrier inside said enclosure.

22. An installation as claimed in claim 21, further comprising fluid distributing means in said enclosure for distributing the gaseous fluid to said material carrier and sealing means for forming a fluid seal between said distributing means and said material carrier, said fluid distributing means and said sealing means being configured for sealingly mating said distributing means with a plurality of material carriers of differing configurations.

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